Defining Models for Project Management Processes

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Defining Models for Project Management Processes

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Dedicated to

my mother Simar Kaur

and

my Late Father Awtar Singh

who with their very hard struggle in life

taught me the power of hard work and perseverance and always endeavour to get the knowledge and education

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Date: Feb 19, 2018 **Ravinder Singh**
London

Abstract

This research would be able to study if formalising project management is feasible. With this research an attempt is made to define and describe the models for complete PMBOK standard taking into consideration all the process and knowledge management areas. This research will focus on the use of UML and OCL for creating model driven project management using PMBOK as base. Some previous research has been done to build simple models that for one process or knowledge management area and even that does not make use of model driven UML and OCL concepts. These research works focussed on creating more of structured flow rather than object models. This research focuses on PMBOK since more than 68% of the projects around the world use PMBOK for managing projects.

The research problem to be addressed are: Feasibility of defining/ formalisation of PMBOK processes, defining meta models for core PMBOK processes, Define mapping of meta models to PMBOK, high level models for Program Management, Onshore/ offshore management, Change Management, due diligence, IT Service management. Analyse the application of proposed formal methods/ models in one or two case studies and do the Fit/Gap analysis to document the shortcomings/ gaps with respect to the compliance to PMBOK 5th Edition.

The benefits of having meta-models will include support for defining tools for project management, deliverables and documentation, and to improve consistency between different areas and processes of PMBOK. It will potentially benefit other projects as the tools, documents and deliverables can be reused. This will make project monitoring and controlling easier during the execution and whole life cycle of the project. The final advantage will come in the form of delivering good quality project on time, budget and scope with improved quality and reliability.

Keywords: Meta-Modelling, UML/OCL, Project Management, Programme Management, Distributed Projects, Onshore/ offshore projects, PMBOK, PRINCE-2, Project Process Management, Project Knowledge Management

Publications

Throughout this PhD, the following publications have been produced:

Papers:

- Singh, Ravinder and Lano, Kevin, "Defining and Formalising Model Driven Approach for PMBOK Processes" published in IEEE International Conference INDIACom-2017 and 3rd International Workshop on Information Engineering and Management IWIEM 2017, March 1-3, 2017
- Singh, Ravinder and Lano, Kevin, "Defining and Formalising Project Management Models and Processes", published in International Journal of Advanced Research in Computer and Communication Engineering (IJARCCE), Volume 5, Issue 6, June2016, Impact factor 5.332
- Singh, Ravinder and Lano, Kevin, "Literature Survey of previous research work in Models and Methodologies in Project Management", published in International Journal of Advanced Computer Science and Applications (IJACSA), Vol. 5, No. 9, Sept 2014, Impact factor 1.324
- Singh, Ravinder and Lano, Kevin, "Defining and Formalising Project Management Models and Processes", published and presented in IEEE Science and Information (SAI) Conference 2014, August 27-29, 2014, London U.K, pp 720-731
- Singh, Ravinder and Lano, Kevin, "Development Process Patterns for Distributed Onshore/Offshore Software Projects", published in International Journal of Advanced Computer Science and Applications (IJACSA), Vol. 5, No. 6, June 2014, pp 70-88, Impact factor 1.324

Book

- Published 2 papers as chapters as one of the editors in the Book titled, "Model driven Business Process Engineering", Lano, Kevin, Singh, Ravinder, Maroukian, Krikor, published by Bentham Science, May 2014 and Amazon, 2015

Conferences:

- Keynote presentation on "Processes for Managing Service Transition Efficiently" at 6th itSMF South East European Conference, Athens, Greece, April 19, 2013.
- Keynote presentation on "Model Driven Project Management", in 21st International Conference on Interdisciplinary Mathematics, Statistics and Computational Techniques (IMSCT 2012-FIM XXI) at Panjab University, Chandigarh, India, Dec 15-17, 2012
- Expert Talks in workshop on "Software Project and Process Management", at BBSBEC, Fatehgarh Sahib, India, Dec 17-20, 2012

- Presentation on “Model Driven Approach for Programme Management” in Model Driven Business Process Engineering Workshop, KCL, London, April 30, 2012.
- Singh, Ravinder and Lano, Kevin, “Analysis of Previous Research work in Models and Methodologies in Programme/ Project Management” in Model Driven Business Process Engineering Workshop, KCL, London, April 30, 2012

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1. Introduction

Projects, Programmes, Portfolios are taken at all levels of organisation which may be involving one or many units and they can involve one or 100s of persons. The duration of projects can vary from few weeks to many years. Projects can be simple to highly complex projects, which may be implemented at one location or multiple locations across multiple countries. This research will evaluate use of models for various real-life project management applications in various industries.

Project Management (PM) in broader context means programme management, practice management, portfolio management, Project management office, etc. Project management system is a set of tools, techniques, methodologies, resources, and procedures used to manage a project. This research is an attempt to create a hierarchy of plan, analyse, design, build, test, deploy and various risk, quality and configuration requirements to address project management.

The research will focus on studying the feasibility of defining/ formalising model driven project management using PMBOK (Project Management Body of Knowledge) as base. This is a unique attempt to define and describe the complete PM standard taking into consideration all the process and knowledge management areas. Previous research has been done to build simple models for one of the processes or knowledge management areas and even that does not make use of model driven concepts. These research works focussed on creating structured flow models rather than object models. This research focuses on PMBOK since more than 68% of the projects around the world use PMBOK for managing projects (source PMI, PRINCE-2, 360PMO [95] and knowledgetrain [96]).

1.1 Research problem to be addressed is

1. Study the feasibility of formalising the essential core models for the PMBOK. The scope is restricted to the core models as the PMBOK areas and work is huge, this was approved in the first transfer report. A case study will be used to check the compliance with PMBOK and this will be done using Fit/Gap analysis.
2. The formalisation of Project Management (PM) process based on PMBOK and its feasibility:
    - Definition of meta models and rules for PMBOK processes
    - 5 Project Management Process Groups
    - 10 Project Knowledge Areas
    - 47 Project Management Processes
    - Define mapping from the PMBOK standard to the metamodels
3. Define high level models for the following:
    - Distributed Onshore/ Offshore software projects
    - Programme Management

4. Application of model to project case study to see the differences/ enhancements/ feasibility
    - Fit/Gap analysis to analyse the errors/ shortcomings with conformance to PMBOK

1.2 Originality of Research

This is a unique attempt to define and describe all the process management groups and knowledge management areas of PMBOK standard. Literature survey shows that the previous research works have been done and focussed on to build simple models for one of the processes or one of the knowledge management areas. The analysis of the previous research works show that they did not make use of model driven concepts. These research works focussed on creating structured flow models rather than object models. Previous research works have a very limited scope and applicability in the real-life environments/ scenarios as the PM processes are interlinked and require sharing of information from one process to another.

This work proposes a model driven project management based upon all the Process and Knowledge management areas of PMBOK making use of modelling languages like UML and OCL. The aim is to help project managers have models which can be used to generate various deliverables, documentation and aids like PM plan, network diagram, risk plans, communication plans, scope, etc. These models will facilitate in organising project activities effectively for efficient management of projects and could serve as full specifications for PM support tools. They will provide large scale applications of systems modelling.

Considering PMBOK standard as base because majority of projects use PMBOK, meta-models were defined for the process and knowledge management areas. The potential benefits of having meta-models include the following:

- Support for defining tools for project management, deliverables and documentation, and to improve consistency between different areas and processes of PMBOK.
- Scope changes, budget and time could be managed more effectively as it would be easier to identify the change in the model.
- Reusability of tools, documents and deliverables.
- Consistency and reliability in the management of various projects.
- Easier project monitoring and controlling for the execution and full life cycle of the project.
- Overall customer satisfaction as risk and issues could be managed more efficiently and effectively using a model.
- Automation of project management standard process.

2. Overview of Project Management Methodologies

2.1 Background and Motivation

An independent study was published by Wellingtone Project Management called “The State of Project Management Annual Survey 2017” on various challenges, difficulties and performance of projects. The survey was conducted in 317 organisations and 686 professionals responded to it.

The survey highlighted various changes in the project headlines from 2016 to 2017:

- Difficult PM processes to embed:
  - Benefits management
  - Lessons learned
  - Change control
  - Resource management
- Biggest challenges:
  - Poorly trained PMs
  - Running too many projects
  - Lack of senior management support
  - Poor resource management

Project performance	2016	2017
Delivered on time	32%	37%
Delivered project benefits	31%	35%
Delivered on budget	31%	42%
Projects schedules not Baselined	34%	34%
Project Scoping document	60%	60%
PPM tool implementation like MS Projects	50%	>50%

The survey also drew attention to the aspects of PMO (Project Management Office) and Project management maturity in the organisations:

The Future of the PMO

- 85% of organisations have a PMO (up from 71% in 2016)
- Only 52% however have a PMO strategy

- Only 33% tend or totally agree the PMO remit and objectives are clear
- Although only 36% predict an increase in future PMO resources, 54% predict an increase in scope & responsibilities

Project Management Maturity

- 55% of PMs create a scoping document during the planning stage always or most of the time
- 66% of project schedules are baselined
- 50% of participants are somewhat or very dissatisfied with the current level of PM maturity in their organisation

These results indicate that a standard methodology is required to deliver projects efficiently and effectively within time and budget. There are two main standards for project management i.e. Project Management Body of Knowledge (PMBOK) by PMI, USA and PRINCE-2 by APMG, UK. PMBOK is more dominant standard as this is used in more than 68% of the project managers around the world. In 2017, there are 774,406 registered PMI/ PMP members (increased from 387,000 in 2012). In 2017, there are 371,707 PRINCE-2 members increased from 144,000 in 2012). Therefore, 68% professionals follow PMI/PMP and 32% follow PRINCE-2. (source PMI, PRINCE-2, 360PMO [95] and knowledgetrain [96]). Therefore, PMBOK standard methodology has been chosen for the formalisation as this is followed by more project managers in the world than PRINCE-2.

Software/ IT projects use various methodologies such as SSADM, RUP, Spiral Model, Scrum, Extreme Programming, etc. and management methodologies such as PMBOK, PRINCE-2. According to Project Management Body of Knowledge (PMBOK) [1], a project is a temporary endeavour undertaken to create a unique product, service or result. According to PMBOK project management is realised through the combination and practice of five project management processes: Initiating, Planning, Executing, Monitoring and Controlling, and Closing. PMBOK divides project management into ten knowledge areas of Integration, Scope, Time, Cost, Quality, Human Resource, Communication, Risk, Procurement, and Stakeholder Management. Project management is the effective use of processes, procedures, tools, techniques along with knowledge, and skills to meet project objectives. Project managers have to manage the traditional Triple constraints – "Scope, Time, and Cost", which have been enhanced in recent time with three more constraints called "Quality, Risk and Customer Satisfaction".

PRINCE-2 [2] describes a project as "A management environment that is created for the purpose of delivering one or more business products according to specified business needs". The PRINCE-2 process model comprises of eight distinctive management processes namely Starting up a Project (SU), Directing a Project (DP), Initiating A Project (IP), Planning (PL), Managing Stage Boundaries (SB), Controlling a Stage (CS), Managing Product Delivery (MP), Closing a Project (CP) which covers the full life cycle of a project. PRINCE-2 is a de facto standard used extensively in UK government.

A key standard amongst maturity models for Portfolio, Programme, and Project Management is P3M3 [3]. This offers a framework for organizations with which they can assess their current performance and develop/ implement improvement plans with measurable outcomes based on industry best practice

2.2 Project Management Body of Knowledge (PMBOK)

PMI (USA) developed a Project Management Body of Knowledge (PMBOK) [1], which can be described as collection of project management knowledge. Similar to other professions like engineering, medicine, accounting etc., this body of knowledge rests with professionals in the project management field who use this knowledge and also propose advancements in it. PMBOK provides good practices, knowledge, tools, skills, and techniques for better, efficient and effective project management. It does not mean that all the things described can be applied to all projects, but has to be modelled and tailored depending on the various constraints of the project like size, budget, time, location etc. PMBOK also describes the common terminology and language for project documentation, reports, writing etc. This makes it easier for all to understand and work on the project by reducing the communication gap.
According to PMBOK [1], differences among project, program and portfolio management is as follows:

Table 2.1 Comparative Overview of Project, Program and Portfolio Management

	PROJECTS	PROGRAMS	PORTFOLIOS
Scope	Projects have defined objectives. Scope is progressively elaborated throughout the project life cycle.	Programs have a larger scope and provide more significant benefits.	Portfolios have a business scope that changes with the strategic goals of the organization.
Change	Project managers expect change and implement processes to keep change managed and controlled.	The program manager must expect change from both inside and outside the program and be prepared to manage it.	Portfolio managers continually monitor changes in the broad environment.
Planning	Project managers progressively elaborate high-level information into detailed plans throughout the project life cycle.	Program managers develop the overall program plan and create high-level plans to guide detailed planning at the component level.	Portfolio managers create and maintain necessary processes and communication relative to the aggregate portfolio.
Management	Project managers manage the project team to meet the project objectives.	Program managers manage the program staff and the project managers; they provide vision and overall leadership.	Portfolio managers may manage or coordinate portfolio management staff.
Success	Success is measured by product and project quality, timeliness, budget compliance, and degree of customer satisfaction.	Success is measured by the degree to which the program satisfies the needs and benefits for which it was undertaken.	Success is measured in terms of aggregate performance of portfolio components.
Monitoring	Project managers monitor and control the work of producing the products, services or results that the project was undertaken to produce.	Program managers monitor the progress of program components to ensure the overall goals, schedules, budget, and benefits of the program will be met.	Portfolio managers monitor aggregate performance and value indicators.

PMBOK [1] defines a project as follows:

✓ A temporary endeavour to create a unique product, service or a result.

- ✓ Creates a unique product, service or result.
- ✓ Is progressively elaborated – distinguishing characteristics of each unique project will be progressively detailed as the project is better understood.

According to PMBOK [1]:

- Temporary means that every project has a definite beginning and a definite end. Projects are not on-going efforts.
- Unique Product means a product or an artifact that is produced, is quantifiable, and can be either an end item in itself or component item.
- A capability to perform a service, such as business functions supporting production or distribution.
- A result such as outcomes or documents e.g. research project.

Progressive Elaboration is a characteristic of projects that accompanies the concepts of temporary and unique. This means developing in steps and continuing by increments. Progressive elaboration is not scope creep.

Management by objectives (MBO) has three steps:

- ✓ Establish unambiguous and realistic objectives.
- ✓ Periodically evaluate if objectives are being met.
- ✓ Implement corrective action.

Project managers have to manage the traditional triple constraints of Cost, Time, and Scope. The new demands in the project management emphasises three more constraints of Quality, Risk, and Customer Satisfaction which the project manager should manage. Prioritisation of the constraints may be managed by the management directly or indirectly.

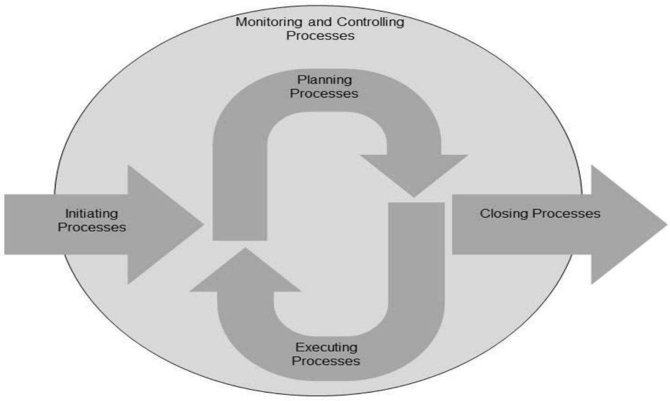
The stakeholder in the project is someone whose interests and whose influence may be positively or negatively impacted by the project. Negative stakeholders are often overlooked by the project team at the risk of failing to bring their project to successful end. The key stakeholders in the project are project manager, customer, performing organisation, users, project team, sponsor, and project management office (PMO). All of the stakeholders must be identified, documenting their requirements, communicating and managing their expectations and influences on the project. Project management team has professional responsibility towards all of its stakeholders and public in general. PMI members must adhere to the “Code of Ethics” and Project Management Professionals (PMP)” certification should adhere to a “Code of Professional Conduct”.

Projects are approved depending on the strategic objectives of the organisation such as Market demand, organisational need, customer request, technology advance, legal requirement, etc.

Project management system is described as a set of tools, techniques, methodologies, resources and procedures. PMI divides project management into professional and social responsibility knowledge areas and process groups. The PMBOK describes the integration among project management processes, the relations among them and function they serve. PMBOK combines these processes into five process groups which are defined as Project Management Process Groups which are Initiating Process Group, Planning Process Group, Executing Process Group, Monitoring and Controlling Process Group, and Closing Process Group.

Even though the project management processes are presented as discrete elements, but they overlap and project management professionals can manage the project in different ways. The objectives of the projects can be defined based on the complexity, risk, size, time, resources, documents, deliverables, application area, geographic spread, experience, and maturity of team and organisation. The concept of interaction and overlapping of PM processes can be traced to Plan-Do-Check-Act (PDCA) cycle.

The Planning Process Group corresponds to "Plan" component of PDCA, the Executing Process Group corresponds to "Do" component of PDCA, the Monitoring and Controlling Process Group corresponds to "Check and Act" component of PDCA as shown in the Figure 2.1 below:



Project Management Process Groups mapped to the PDCA Cycle (Plan-Do-Check-Act)

Figure 2.2 Project Management Processes as PDCA cycle

PMI further divides the project management into ten Knowledge Areas which are Project Integration Management, Project Scope Management, Project Time Management, Project Cost Management, Project Quality Management, Project Human Resources Management, Project Communications Management, Project Risk Management, Project Procurement Management, and Project Stakeholder Management.

Project Integration Management: it describes the processes and activities which integrate various components of the project.

Project Scope Management: This describes the processes which are used to calculate the scope, and only the work required, for successful completion of the project.

Project Time Management: defines the processes for completing the project on time.

Project Cost Management: describes process for estimating, planning, budgeting and controlling the cost of the project.

Project Quality Management: defines the processes for assuring that the project is delivered as per the required standard and objectives.

Project Human Resource Management: defines the processes for managing the human resources for the project.

Project Communication Management: describes the collecting, processes for processing, sending and receiving the information to the appropriate channels.

Project Risk Management: describes the processes for managing, prioritising, and mitigating risk for the project.

Project Procurement Management: describes the processes for contract management for purchasing any services, results or products.

Project Stakeholder Management: discusses the processes for managing stakeholders and understanding their expectations and managing them effectively.

2.3 PRINCE-2

PRINCE-2 (**PR**ojects **IN** **C**ontrolled **E**nvironments) [2] is a structured method for effective project management. The method was developed first in 1989 by CCTA (The Central Computer and Telecommunication Agency). The method was adopted from PROMPTII, a project management method developed by Simpact Systems Ltd in 1975. Office of Government (earlier CCTA) further enhanced the method continuously and PRINCE-2 was launched in 1996. PRINCE-2 is based on the information and experiences shared by various experts, professionals in project management field.

PRINCE-2 is a de-facto standard used extensively by UK government. This is also used widely in private sector, but more in UK than internationally.

PRINCE-2 defines a project as, “A management environment that is created for the purpose of delivering one or more business products according to a specified business case”. Another definition of project according to PRINCE-2 is, “A temporary organisation that is needed to produce a unique and predefined outcome or result at a pre-specified time using predetermined resources”.

According to PRINCE-2, project has the following characteristics:

- A finite and defined life cycle.
- Defined and measurable business products.
- A corresponding set of activities to achieve the business products.
- A defined amount of resources.
- An organisation structure, with defined responsibilities, to manage the project.

The PRINCE-2 process model is shown in the Figure 2.2 This model consists of eight distinctive management processes for the full life cycle of the project. The Planning process is used by four of the other processes.

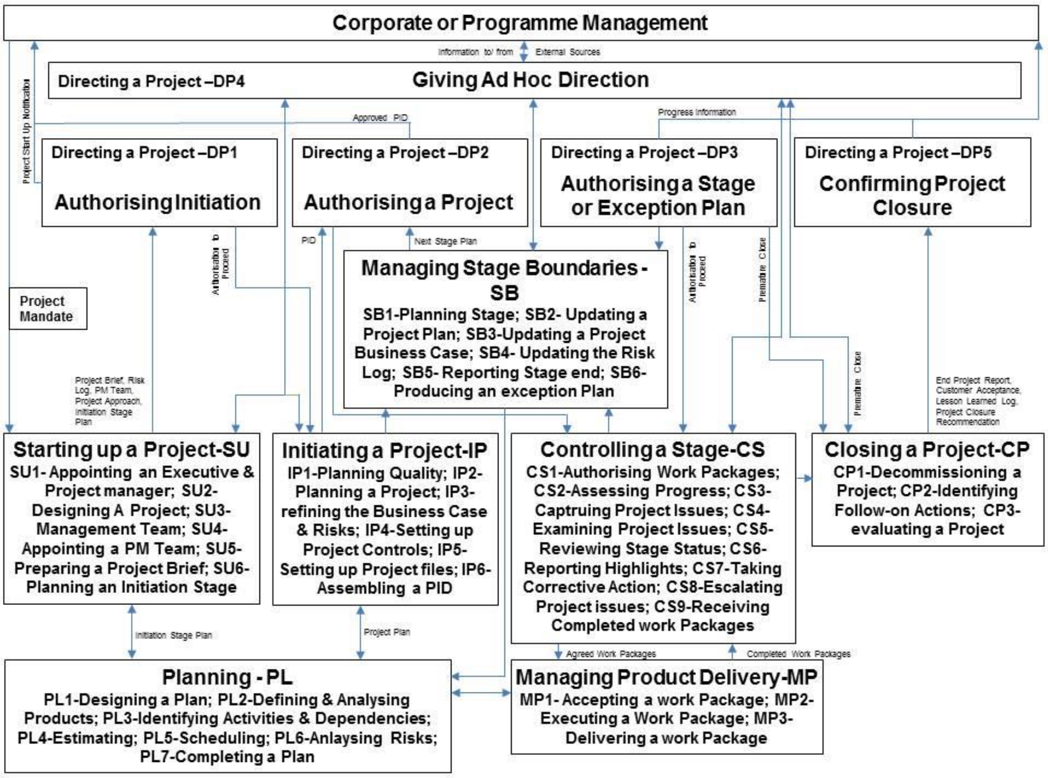


Figure 2.1 PRINCE-2 Process Flow

A project must be able to make use of each of these processes in some form, and this may require tailoring of the processes for the needs of the individual project. Each process should be followed by asking a question about the relevance of the process for the particular project.

PRINCE-2 Strengths

- Organization (Project Boards; defined roles and responsibilities; ownership & accountability)
- Business case–based; on-going assessment of project viability by project owners (Board)
- Product-Based Planning (strictly deliverable oriented); Product Flow; Product Descriptions
- Integrated process structure: clear statement of how to manage the project ("How do I get started? What do I do first?")
- Clear quality management points (esp. Quality Control), and Quality Assurance roles and responsibilities
- Defined and orderly handling of Work Packages (Managing Product Delivery)

2.4 PMBOK and PRINCE-2 Comparison

Table 2.2 Basic contrast between PMBOK and PRINCE--2

PMBOK	PRINCE-2
Comprehensive	Focusses on key risk areas only; does not claim to be complete
Largely descriptive, prescriptive on a high level	Highly prescriptive, especially on Process Structure, but adaptable to any size project

PMBOK	PRINCE-2
Core and facilitating processes; need to be scaled to the needs of the project	All processes should be considered; also need to be scaled
Customer requirements driven	Business case driven
Sponsor and stakeholders	Clear project ownership and direction by senior management
International/ UK standard	UK standard

PRINCE-2 is built on seven elements, or Themes: Business Case, Organization, Plans, Progress, Risk, Quality, and Change (comprising configuration management and change control). They roughly map against the nine PMBOK Knowledge areas as follows:

Table 2.3 Mapping of PMBOK Knowledge Areas to PRINCE-2

PMBOK Knowledge areas	PRINCE-2 components/ Themes
Integration	Combined Processes and Components/ Themes, Change Control
Scope, Time Cost	Plans, Business Case
Quality	Quality, Configuration Management (Change)
Risk	Risk
Communications	Controls
HR	Organisation (limited)
Procurement	Not Covered
Stakeholder	Not Covered

Table 2.4 Five processes groups of PMBOK map against the PRINCE-2 processes

PMBOK	PRINCE-2 (Project Level)	PRINCE-2 (Stage Level)
Initiating	Starting Up; Directing	Managing Stage Boundaries; Directing
Planning	Initiating, Planning	Managing Stage Boundaries; Planning
Executing/ Controlling	Managed on a stage-by-stage basis	Controlling a Stage; Managing Product Delivery; Directing
Closing	Closing a Project	Managing Stage Boundaries

2.5 Outline of Thesis

Chapter 3 provides an overview of the previous and current trends in the field of project management. The chapter categorises the work into Project Management Models/ Frameworks, Use of Modelling in Project Management, Project Management in IT and Software Projects, Managing Projects in R&D Organisations, Empirical and Statistical Analysis, Use of Alternative Methodologies, Effects of Leadership and Management Qualities of Project Manager, Project Management in Global Distributed Environment, Project Management Maturity Models. The detailed analysis of papers is in given in Appendix-3

Chapter 4 defines the objectives of the Project Management and depicts modelling language used for developing the formalised models for Project Management in this research work.

Chapter 5 describes PMBOK based Project Management Process groups. Project Management is defined as managing the project using processes defined in the Project Plan. Project management define how to manage a single project or one project within a series of planned projects or releases. PM determines the problems to solve for the client and agree on the project's objectives. PM would be able to deliver one or more custom-built applications as the solution's key elements. Project Management is to manage the project within triple constraints of Cost, Time, and Scope. Three constraints of Quality, Risk, and Customer Satisfaction are added to it also so that projects can be better managed as per stakeholders' expectations. Meta models are described and developed taking all the process and knowledge management areas of PMBOK.

Chapter 6 explains the Project Knowledge Management Areas as defined by the PMBOK. PMBOK 5th edition describes the Knowledge Area as a full set of notations, relations, procedures, tools, and techniques. This chapter defines the formalised models for these knowledge management areas.

Chapter 7 describes Program management and defines models for program management. Program Management is described as the management of number of projects in order to achieve the desired objectives or results or goals of the organisation as managing the projects individually could not produce the desired outcome. Each project in the program is associated in a systematic way to the program by the central objectives or benefits. A program usually has a longer life span in years and during the program many projects are started, accomplished and closed. The Program Management focuses on planning, mobilizing, and managing a program at a client site with high-quality execution and to achieve the strategic goals and objectives of the organisation.

Chapter 8 describes the Development Process Patterns for Distributed Onshore/Offshore Software Projects. The globalisation of the commercial world, and the use of distributed working practices (Offshore/ onshore/ near-shore) has increased dramatically with the improvement of information and communication technologies. Many organisations, especially those that operate within knowledge intensive industries, have turned to distributed work arrangements to facilitate information exchange and provide competitive advantage in terms of cost and quicker delivery of the solutions. The information and communication technologies (ICT) must be able to provide services similar to face-to-face conditions. Additional organisations functions must be enhanced to overcome the shortcomings of ICT and also to compensate for time gaps, cultural differences, and distributed team work. The proposed model in this research identifies four key work models or patterns that affect the operation of distributed work arrangements, and this research also proposes the guidelines for managing distributed work efficiently and effectively.

Chapter 9 analyses the application of the formalised project management models in a large case study.

Chapter 10 summarises the research conducted in this thesis, and how the goals stated in Chapter 1 have been demonstrated by the case study discussed in the thesis. The directions for future research, and how the models can be enhanced for full scale automation of the project management work are described in this chapter.

3. Related Research

Project management is a very complex field and encompasses technical skills along with man management skills to manage stakeholder expectations. Projects are influenced by both internal and external factors and require various communication channels and techniques to reduce the gap and deliver project effectively and efficiently.

The studies have been conducted to understand the existing standard models [4-8] and adapt them so as to manage projects in a better way. Modifications have been suggested so as to make existing methodologies work in different areas of work. The studies showed that different methodologies could be suitable for different types of projects. It has also been proposed that tailoring of methodologies would be more useful for different scenarios providing efficient and effective project management and control. The studies also showed that large complex system can be better managed and controlled by dividing the system into smaller modules or phases.

System modelling, dynamic modelling, estimation models and object-oriented modelling concepts have been investigated for improving the project management [9-12]. The studies showed that system modelling would be useful to have better communication among different stakeholders by managing various communication means, channels and modes. The studies showed that risks could be forecasted and managed more effectively by the use of dynamic modelling. The studies also showed that object oriented modelling concepts and properties like inheritance, modularity, data-encapsulation, relations could be used to describe the life cycle of the projects and manage it more efficiently. The studies proposed a mathematical model for estimating and forecasting along with the use of iterative development for better monitoring and control of the project.

Software and ICT projects have their own challenges due to rapid technological advances, providing better services, facilities etc. Therefore, standard project management methodologies only may not be sufficient for managing project in this area. These methodologies may have to be enhanced and that's the reason that Agile, JAD, RAD, extreme programming have been developed [13-22]. The studies also showed that project management methodologies/ models should be customised/ tailored for the different projects so as to best fit the scenario and hence avoid unnecessary details and reduce cost and time. The studies also tried to combine different methodologies and framework like RUP, PMBOK, agent framework, metaphors and graphical presentations for creating new frameworks/ models to suit the requirements for managing, controlling, and execution of the project successfully within time and budget. The studies demonstrated that better estimates could be achieved and also stakeholders could manage in a better manner for overall success of the project. The studies also showed that quality control tools/ methodologies like ISO, CMMI would be highly useful in delivering good quality projects.

Stakeholders have different set of obligations, constraints, necessities, and expectations as projects in R&D organisations are knowledge intensive requiring more sharing of ideas. These differences have been highlighted in the research papers [23-24]. The studies showed that knowledge sharing areas/ sites for the researchers to share/ propose/ discuss their ideas by using blogs, discussion groups, and chat rooms would be highly useful to enhance creativity and innovations.

Researchers had been able to study various project management methodologies, tools, and techniques etc. empirically and statistically [25-33]. The studies showed that various factors like Management commitment, financial constraints, organisational structure, reward system, education and training of project teams play a crucial role in the successful management of projects. The project managers also tailor their methodology to suit the needs to reduce the cost and time for delivering the projects. The studies also proposed that scope and change management training would be highly useful to project managers for executing, monitoring, and controlling the projects successfully. The studies also showed that in new dynamic environment newer technologies would be more useful than traditional models of development and management of projects. Various techniques like critical path method, PERT, baselining, scope, change, and risk management would be of great help for successful delivery and management of the projects.

They had collected data from various projects to study different areas of project management and models can potentially be used to represent PM assets for reuse, and to support formal analysis. Use of alternative statistical techniques and models such as Fuzzy Logic, NPV, approach-avoidance theory, had been explored in the project management area [33-38]. The studies showed that techniques like NPV, fuzzy logic would be highly useful in estimating and forecasting the project execution with better monitoring and control of the projects. The studies also showed that decision tree analysis, fishbone or cause-effect diagrams could be used effectively to manage quality, risks and deliver successful projects. Project managers need different skills/ tools/ techniques / methodologies to manage various projects efficiently.

Leadership abilities, communication and management abilities along with IQ, EQ, and MQ of the project manager have a huge impact on the projects [39-42]. Teaching of project management is not only about just teaching of GANTT and PERT chart but also must include various software and other tools for successfully managing projects. The studies have shown that project managers should use various communication tools/ methods with different stakeholders. Project managers should have the qualities to be a good team player, manager, having the ability to take decisions with responsibility to deliver successful projects. The studies showed that project manager should be able to manage the expectation of team members, motivating them, understand their training needs and communicate them at different levels so to manage various stakeholders, teams in a better manner and make them more productive.

Distributed environment of projects in the present multinational organisations gives rise to more complexities in all areas of project management [43-66]. Therefore, standard project management methodologies have to be enhanced to meet diverse requirements from various stakeholders. The studies showed that distributed work environment has its own challenges and advantages. The challenges could be such as managing different time zones, cultural differences, virtual communication environments and costs associated with them, and many more. The advantages could be in terms of providing good quality projects at lower cost. This requires proper documentations, setup the correct expectations, managing various stakeholders and also managing the cross-cultural issues effectively and efficiently. The conflict resolution criterion and transparent communication is the key to success in global scenarios and managing successful projects.

Maturity level is able to give the reliability of organisation in a particular area [67-76]. There are a number of maturity and capability levels for project management such as $(PM)^2$, OPM3, CMMI, IEEE, etc. against which an organisation can be appraised. The maturity models take into account PM processes, factors and characteristics and shows the organisation's progress from functional to project driven organisation. The maturity models describe how mature the processes are, the success rate of the organisation in past, and also the probability that it would be able to deliver good quality projects. The organisation could use these models to build robust processes and also optimise them with feedback and changing scenarios and environment.

Karolina M. [97] discussed the role of communication in project management area. The author proposed new patters for management of project communication and so that project managers can be provide more effective communication. This paper is able to focus on only one area of project management which is project communication management.

New ways of communication management in IT project management had been described in this research paper [98] on rethinking communication. The research shows that standard models may not be sufficient where more human interaction and communication is needed. The research proposes alternative and new ways of rethinking the communication based on productive and interceptive aspects along with the use of language games. This research is limited in scope to project communication management area only.

Problems in managing software projects and project risk management were discussed in the research by Su and Wen [99]. The authors then propose a strategy to enhance the quality of managing the software projects. The author shows that by improving the CMMI processes in the organisation. The limitation of this paper is that it focusses on project quality management area only.

Risks in the engineering projects are described in the research paper by Xiaohua Sun [100]. The author also provides application of risk analysis and management techniques to such projects and proposes approaches to manage them more effectively. This research is limited in scope only to one area of project management that is project risk management.

Project governance and its importance for benefits realisation as well as successfully delivering the project were discussed in this research paper [101] on effective project governance. The authors conducted a survey on 333 projects and got feedback from 21 project governance experts and observed that good project governance strategies result in better project management, delivery and successful benefits realisation. The scope of the research is limited to some areas of monitoring and controlling, execution & closing the project.

The research paper [102] applied agency theory and stewardship theory perspective to develop a relation between project success and project governance. The authors provided analysis of feedback from 254 responses and observed that stakeholder orientation has direct relation to project success but there may not be a direct correlation of project success with the type of control mechanism. This research also has a limitation of scope to the areas of stakeholder management and project monitoring and controlling along with the execution part of project management.

SPEM, BPMN, and PetriNets was evaluated as a possible alternative modelling approach and it was concluded that this would add additional complexity and potentially conflict with the PMBOK. The details are explained in Chapter-13.

As discussed in the section 2.1, PMBOK is the most recognised (de facto) standard of project management, therefore this research will be used to propose a model using UML and OCL for PMBOK processes and knowledge management areas. The model-based approach would help to provide benefits of reusability, consistency, and better reliability of the project delivery.

It has been observed from the literature survey of various research papers that research is limited to the scope of one or a few areas of project management. This research is focussed on all areas of project management and study the feasibility of formalising the essential core models for the PMBOK (Project Management Body of Knowledge) as base. This is a unique attempt to define and describe the complete PM standard taking into consideration all the 5 process groups and 10 knowledge management areas along with 47 project management processes. Previous research papers focussed to build simple models for one of the processes or knowledge management areas and developed structured flow models rather than object models.

4. Project Management Model

4.1 Model Based Project Management

The main objective of Project Management is to manage the processes defined in the project plan. This involves managing the project risks and issues to ensure that the project meets the business objectives and stakeholder expectations in a coordinated and timely manner and satisfies formal reviews and sign-offs.

Project management should ensure that stakeholders' concerns are acknowledged and appropriately addressed and provide the necessary support to enable stakeholders to meet the project goals.

PM should be able to balance scope, quality, effort, schedule, budget, and risks at all times. PM has to identify the appropriate solution and risk mitigation strategies using standards, documented decision analysis and resolution processes when the projected impact of an issue or a risk exceeds the project threshold.

PM has to ensure that the project methods, standards, and approaches are followed and facilitate deliverable transitions between project life cycle stages and ensure that key project deliverables are effectively transitioned and placed under configuration management.

PM should implement quality management process such as process and product quality assurance (PPQA) and other quality-related reviews (e.g., Quality and Process Improvement or best practice reviews). On completion of project PM should transfer responsibility for ongoing maintenance to the appropriate entity.

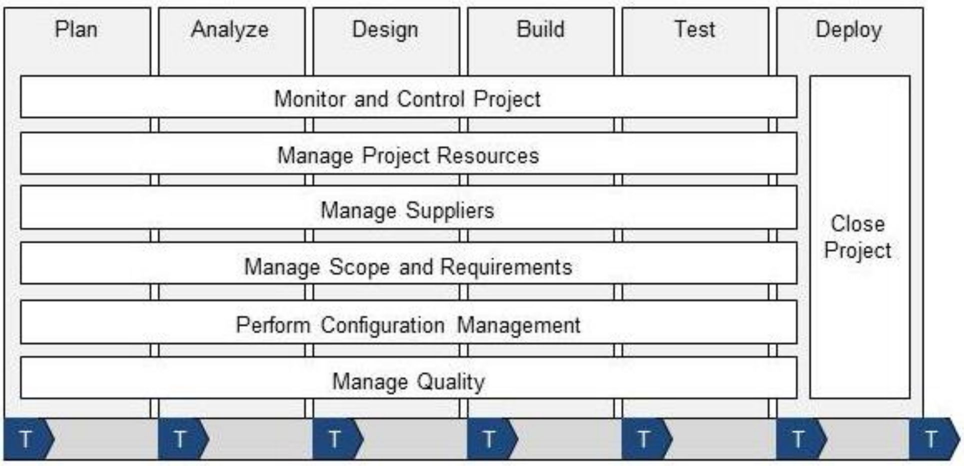


Figure 4.1 Project Management Processes

4.2 Modelling Language used

In this research, UML-RSDS is being used as a subset of UML for modelling. Added advantage is that, this language is supported at KCL. The diagrams which are shown in the research work are at M1 (application) level. Hence operations are used in the model and class diagrams. Those models could be potentially used in future research as a specification for creating automation tools for project management and deliverables.

4.3 What Part of PMBOK will be modelled?

The research uses the formalisation and models based on the mapping of Project Management Process groups and knowledge areas as per PMBOK 5th edition is as shown in Table-1 and the activity diagram shown in Fig. 4.2 to evaluate the case studies and the effectiveness of the proposed approach to identify the gaps between the model and the project/ case study.

This would help to map the model/ formalisations based on the PMBOK 5th edition and apply it to the case study/ project for evaluation.

The research has been focussed on the following:

- Definition of meta models and rules for PMBOK processes
- 5 Project Management Process Groups
- 10 Project Knowledge Areas
- 47 Project Management Processes
- Define mapping from the PMBOK standard to the metamodels

Table 4.1 Project Management Process Group and Knowledge Area Mapping

	Project Management Process Groups				
Knowledge Areas ↓	**Project Initiation Process Group**	**Project Planning Process Group**	**Project Executing Process Group**	**Project Monitoring & Controlling Process Group**	**Project Closing Process Group**
Project Integration Management	4.1 Develop Project Charter	4.2 Develop PM Plan	4.3 Direct and Manage Project work	4.4 Monitor and Control Project work 4.5 Perform Integrated Change Control	4.6 Close Project or phase
Project Scope Management		5.1 Plan Scope Management 5.2 Collect Requirements 5.3 Define Scope 5.4 Create WBS		5.5 Validate Scope 5.6 Control Scope	
Project Time Management		6.1 Plan Schedule Management 6.2 Define Activities 6.3 Sequence Activities 6.4 Estimate Activity Resources 6.5 Estimate Activity Duration 6.6 Develop Schedule		6.7 Control Schedule	
Project Cost Management		7.1 Plan Cost Management 7.2 Estimate Cost 7.3 Determine Budget		7.4 Control Costs	

Knowledge Areas ↓	Project Initiation Process Group	Project Planning Process Group	Project Executing Process Group	Project Monitoring & Controlling Process Group	Project Closing Process Group
Project Quality Management		8.1 Plan Quality Management	8.2 Perform Quality Assurance	8.3 Control Quality	
Project Human Resource Management		9.1 Plan HR Management	9.2 Acquire Project Team 9.3 Develop Project Team 9.4 Manage Project Team		
Project Communication Management		10.1 Plan Communication Management	10.2 Manage Communications	10.3 Control Communication	
Project Risk Management		11.1 Plan Risk Management 11.2 Identify Risks 11.3 Perform Qualitative Risk Analysis 11.4 Perform Quantitative Risk Analysis 11.5 Plan Risk Responses		11.6 control Risks	
Project Procurement Management		12.1 Plan Procurement Management	12.2 Conduct Procurements	12.3 Control Procurements	12.5 Close Procurements
Project Stakeholder Management	13.1 Identify Stakeholders	13.2 Plan Stakeholder Management	13.3 Manage Stakeholder Engagement	13.4 Control Stakeholder Engagement	

The detailed process chart based on various activities to be performed as per PMBOK 5th edition for the overall project management process groups is given in Fig 2. The lists of activities to be performed in various Process Management Groups are listed as under:

4.3.1 Initiating Process Group

- Select a Project Manager
- Determine Company Culture & Existing System
- Collect Processes and Historical information
- Divide large project into phases
- Identify Stakeholders
- Document business needs
- Determine project objective
- Determine Assumptions and constraints
- Develop Project Charter
- Develop Preliminary Project Scope Statement

4.3.2 Planning Process Group

- Determine how you will do planning - part of management process
- Create Project Scope Statement
- Determine Team
- Create WBS and WBS dictionary
- Create Activity List
- Create Network Diagram
- Estimate Resource Requirements
- Estimate Time and Cost
- Determine Critical path
- Develop Schedule
- Develop Budget
- Determine Quality, Standards, Processes, & Metrics
- Determine Roles and Responsibilities
- Determine Communication requirements
- Risk Identification, Qualitative and Quantitative Risk Analysis & Response planning
- Iterations – Go back
- Determine what to purchase
- Prepare Procurement documents
- Finalize the “How to Execute & Control” aspects of the management plans
- Create Process Improvement plan
- Develop final PM Plan & Performance Measurement Baselines
- Gain Formal Approval
- Hold Kick-off meeting

4.3.3 Executing Process Group

- Acquire Final Team
- Execute the PM Plan
- Complete Product Scope
- Recommend Changes & Corrective actions
- Send and Receive Information
- Implement approved changes, defect repair, preventive and corrective actions.
- Continuous Improvement
- Follow Processes
- Team Building
- Give Recognition and Rewards
- Hold progress meetings
- Use work authorization system
- Request Seller Response
- Select Sellers

4.3.4 Monitoring and Controlling Process Group

- Measure against the Performance Measurement Baselines
- Measure according to the management plan
- Determine variances, and if they warrant corrective action or a change
- Scope Verification
- Configuration Management
- Recommend changes, defect repair, preventive and corrective actions
- Integrated change control
- Approve changes, defect repair, preventive and corrective actions
- Risk Audits
- Manage reserves
- Use Issue logs
- Facilitate conflict resolution
- Measure team member performance
- Report on performance
- Create forecasts
- Administer Contracts

4.3.5 Closing Process Group

- Develop Closure procedures
- Complete Contract Closure
- Confirm work is done to requirements
- Gain formal acceptance of the product
- Final performance reporting
- Index archive records

- Update Lessons Learned knowledge base
- Hand off completed product/ project
- Release resources

The activity workflows which would be followed for linking the project management process, knowledge areas and deliverables to be created as per the PMBOK 5th edition is given below in Fig 4.2:

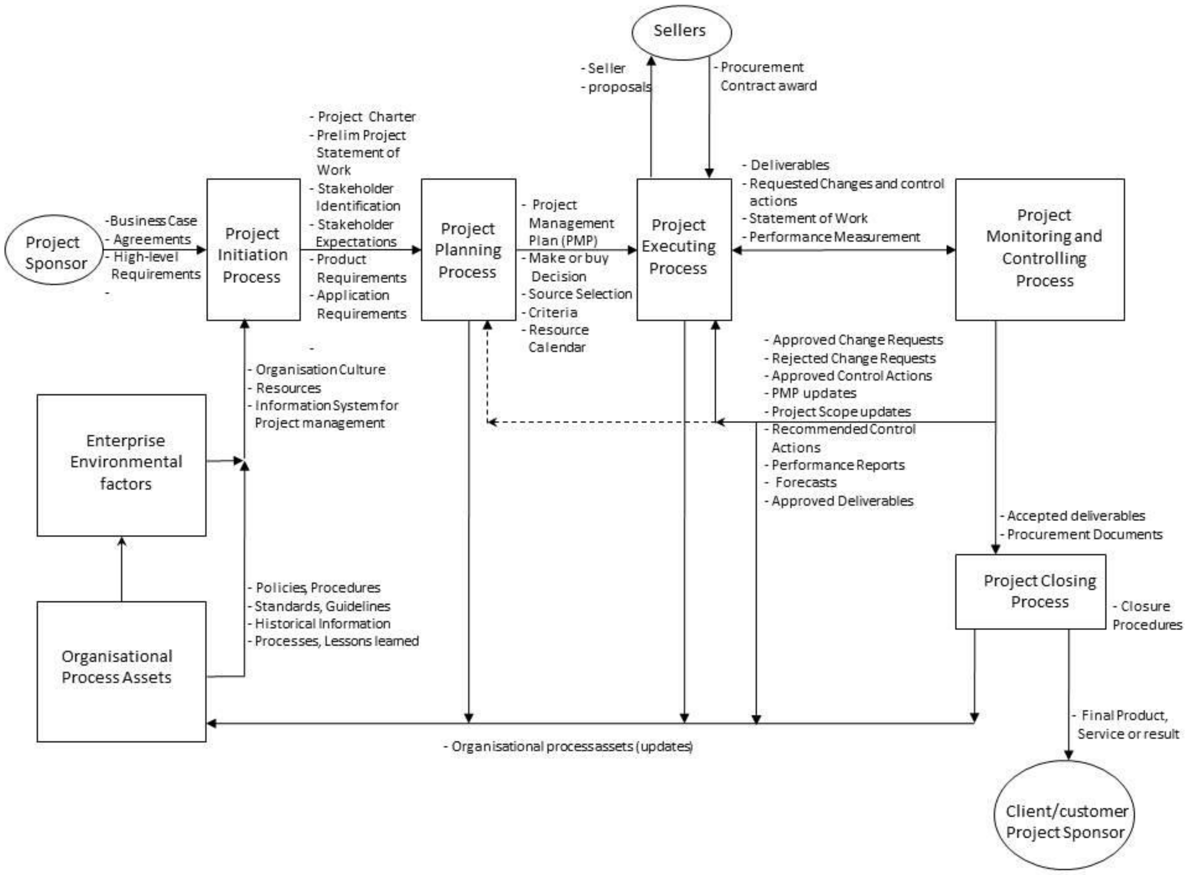


Figure 4.2 Activity Diagram of Project management process and Knowledge areas of PMBOK 5th Edition

The detailed steps and processes to move from one process group to another are listed in Table 4.2. One of the process group Initiating Process Group flow is explained in detail (section 4.4) along with the various documents/ deliverables created in it and how these documents/ deliverables can be used in other process area for creating further project documents/ deliverables.

Table 4.2 The process chart for various steps in all the process management groups

#	1. Initiation	2. Planning	3. Execution	4. Monitoring & Control	5. Closing
1	Create a project	Determine how planning will be done - management plans	Acquire final team	Measure against Performance Measurement Baselines	Develop Closure Procedures
2	Determine company culture & existing systems	Create Project Scope Statement	Execute the PM plan	Measure according to the Management plans	Complete Contract Closures
3	Collect processes, procedures and historical information	Determine Team Structure	Complete Product scope	Determine variances and if they warrant corrective action or a change	Confirm work is done to Requirements
4	Agree Phases for large projects	Create WBS & WBS dictionary	Recommend changes & Corrective actions	Scope Verification	Gain Formal Acceptance of the product
5	Identify Stakeholders	Create Activity List	Send and Receive information	Configuration Management	Final Performance Reporting
6	Document Business Needs	Create Network Diagram	Implement approved changes, defect repair, preventative and corrective actions	Recommend changes, defect repair, preventative and corrective actions	Index Archive Records
7	Determine Project Objective	Estimate Resource requirements	Continuous Improvement	Integrated Change Control	Update Lessons Learned Knowledge Base
8	Document assumptions and constraints	Estimate Time and Cost	Follow Processes	Approve Changes, defect repair, preventative and corrective actions	Hand off Completed Product
9	Develop Project Charter	Determine Critical Path	Team Building	Risk Audits	Release Resources
10	Develop preliminary project scope statement	Develop Schedule	Give Recognition and Rewards	Manage Reserves	
11		Develop Budget	Hold Progress Meetings	Use Issue Logs	

#	1. Initiation	2. Planning	3. Execution	4. Monitoring & Control	5. Closing
12		Determine Quality standards, Processes and Metrics	User Work Authorisation System	Facilitate Conflict Resolution	
13		Determine Roles and Responsibilities	Request Seller Response	Measure Team Member Performance	
14		Determine Communication Requirements	Select Sellers	Report on Performance	
15		Risk Identification, Qualitative and Quantitative Risk Analysis and Response Planning		Create Forecasts	
16		Iterations - Go back		Administer Contracts	
17		Determine What to purchase			
18		Prepare Procurement Documents			
19		Finalise the "How to Execute & Control" aspects of all management plans			
20		Create Process Improvement Plans			
21		Develop final PM plan & performance measurement baselines			
22		Gain formal approval			
23		Hold kick-off meeting			

4.4 Initiating Process Group process flow

The process described in the table 4.2 above is depicted in the Fig 4.3:

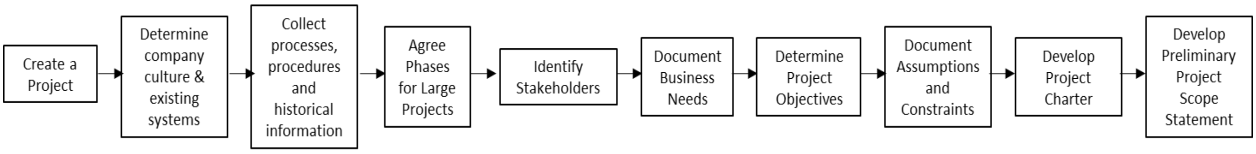


Figure 4.3 Initiating Process Group Process Flow

4.4.1 Identify stakeholders

The stakeholders are identified using the Stakeholder Goals and Expectations Template (given in the appendix A-3). This template helps to capture all the stakeholders, their profile, role, expectations, and involvement in the project. This helps the project manager to manage the project successfully by managing the expectations of all the stakeholders as listed in the template.

This Stakeholder Goals and Expectations Template document and list is used in the following processes:

- Project Planning Process Group
- Project Executing Process Group
- Project Monitoring and Controlling Process Group
- Project Closing Process Group
- Project Stakeholder Management

This document helps to develop various documents and processes in the complete project management process and model. To name just a few this document is used in developing the following documents:

- Develop Project Charter
- Develop Preliminary Project Scope statement
- Create Project Scope Statement

4.4.2 Develop Project Charter

The project charter is such an important document that a project cannot be started without one. A project charter is not a project management plan. Since the project charter provides the target for the project, and a definition of how success will be measured, then without a project charter, the project and project manager cannot be successful. A project charter provides at a minimum, the following benefits:

- Formally recognizes (authorizes) the existence of the project, or establishes the project. This means project does not exist with a project charter.
- Gives the project manager authority to spend money and commit organisation resources.
- Provides the high-level requirements of the project.
- Links the project to the ongoing work of the organisation.

The project charter is also:

- Issued by a sponsor, not the project manager
- Created in the Initiating process group
- Broad enough so it does not need to change as the project changes

The following is an example of what a project charter may include and describes the elements of a project charter.

4.4.3 Develop Project Charter *(template)*

Project Title and Description: (What is the project)

Project manager Assigned and Authority Level: (Who is given authority to lead the project, and can he/she determine, manage and approve the changes to budget, schedule, staffing, etc.?)

Business Need: (Why is the project being done?)

Project Justification: (Business case – on what financial or another basis can the project be justified for being done?)

Resources Pre-assigned: (How many or what resources will be provided?)

The following information is described in Stakeholder Goals and Expectation matrix and is used here to develop project charter:

> **Stakeholders:** (Who will affect, or be affected by the project (influence the project), as known to date?)
>
> **Stakeholder Requirements As known:** (Requirements related to both project and product scope)

Product Description/ Deliverables: (What specific product deliverables are wanted and what will be the end result of the project?)

Constraints and Assumptions: (A constraint is any limiting factor and an assumption is something taken to be true, but which may not be true.)

Project Sponsor Approval:

Approver names and signatures

4.4.4 Develop Preliminary Project Scope Statement

The preliminary project scope statement is the first attempt to determine the project scope – what must be done to accomplish the project objectives. It is developed on the basis of information from the sponsor. The purpose of this document is to make sure that the project manager and the sponsor have the same understanding of the scope before the planning begins.

The preliminary project scope statement provides the following input into the planning process group:

- High-level (or initial WBS)
- Cost estimates
- High-level Schedule milestones
- Identify initial risks
- Project organisation
- High-level In-scope and out of scope requirements
- Acceptance criteria

4.4.5 Create Project Scope Statement

This preliminary scope statement will be further developed to the final project scope statement during the following processes:

- Project Planning Process Group
  - Using the input (as described above) from the preliminary project scope statement, the final project statement is created which has the following information:
    - WBS (from the Initial WBS)
    - Final Cost and budget plans (from Cost estimates)
    - Agreed schedule milestones and timelines (from high-level schedule milestones)
    - Risk and Issue plan (from identify initial risks)
    - Project organisation (from project organisation)
    - Finalised in-scope and out of scope requirements (from high-level in-scope and out of scope requirements)
    - Performance Measurement baselines and Acceptance criteria (from acceptance criteria)

- Project Scope Management
  - Final Project Scope statement is developed using the information from project charter, preliminary project scope statement and identifying the planning activities during the project planning phase.
  - WBS and WBS dictionary is created
  - The final scope statement is approved by the sponsor identified during the Identify stakeholder step.

5. Project Management Process Groups

5.1 Project Initiating Process Group

The Initiating Process Group consists of the processes that assist the formal approval of the project or project phase to start. All the stakeholders of the project are identified along with the development of project charter and scope baselines taking into account various assumptions and constraints.

The *Assumption* class has three attributes of Time, Cost and Stakeholder Approval. The *Constraint* Class has Time, Cost and Location attributes. These classes are associated so that time, cost and location are adhered to as per the requirements of stakeholders.
Class *PM* (Project Manager) has three attributes Rate, Availability and Experience and it has four operations to perform i.e. EvaluateSkills(), CompareRate(), EvaluateExperience() and Hire() . *PM* class is in association with *Skill*s class due to Technical & Management Skills, and Experience required for completing the project. *Skills* class has one operation Evaluate Performance() to perform to inspect the performance of PM on previous projects. The project manager is selected based on the various technical and management skills and experience, and also based on evaluation of the performance of the manager from previous roles/ projects. Final selection is based on the basis of comparing the rates of the manager and availability for the duration of the project.

An organisation's current capability assessment is depicted using the *CurrentCapabilityAssessment* class which comprises of the four operations i.e. DetermineCompanyCulture() and CollectHistoricalInformation(), CollectProcesses() and CollectProcedures, documentation, etc.

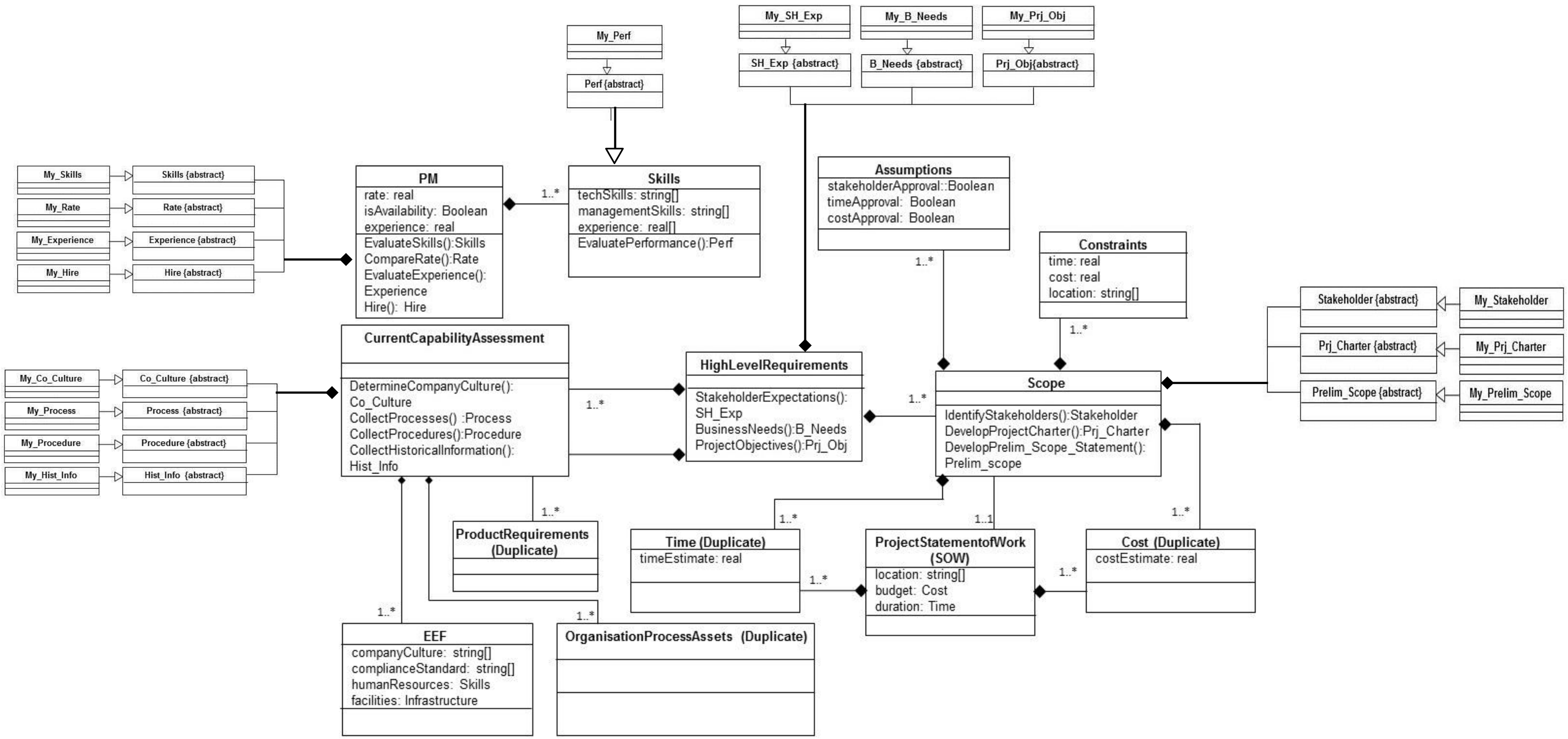


Figure 5.1 Project Initiating Process Group

Class *HighLevelRequirement* or business requirements are documented using three operations StakeholderExpectations(), BusinessNeeds() and ProjectObjectives(). All the stakeholder expectations are documented along with the business need and objectives of the project.

The scope of the project is defined using the *Scope* class using three operations IdentifyStakeholders(), DevelopProjectCharter(), and CalculateScopeBaselines(). All the stakeholders both positively and negatively affected by the project are identified and their needs documented. Project charter is developed highlighting various business aspects of the project. The baselines for the scope are calculated using business objectives, business needs, cost, time, quality, assumptions and constraints. Therefore, *Scope* class is associated with the *Assumption, Time, Cost, Constraint* classes.

ProjectStatementofWork class is used to produce an approved work statement for all the stakeholders of the project highlighting the Location, Cost and Duration of the project.

Duration of the project and cost is calculated using the *Time* and *Cost* class used from Project Planning Group. The estimated time and cost is known from project scope statement. The above diagram is based on the PMBOK [1] Project Initiating Process Group. The mapping of various processes and activities is as follows Table 5.1:

Table 5.1 Project Initiating Process Group mapping

PMBOK[1] processes and activities (section)	**Formalised Model**
Project statement of work (3.3.1)	ProjectStatementofWork (SOW) class
Enterprise Environmental Factors (3.3.1	CurrentCapabilityAssessment class EEF class
Project Charter creation (3.3.1)	PM Class Skills Class Cost Class Time Class DevelopProjectCharter() operation
Develop Preliminary Scope Statement creation (3.3.2)	Scope Class DevelopPrelim_Scope_Statement() operation
Organisational Process Assets (3.3.1, 3.3.2)	OrganisationProcessAssets class (Duplicate)
Identify Stakeholders (3.3.2)	IdentifyStakeholders() operation
Document Assumptions and Constraints (3.3.1, 3.3.2)	Assumptions Class Constraints Class

PMBOK[1] processes and activities (section)	**Formalised Model**
Document Business needs (3.3.1, 3.3.2)	HighLevelRequirements class
Determine Company Culture & existing system (3.3.1, 3.3.2)	DetermineCompanyCulture() operation
Collect Processes, Procedures & Historical Information (3.3.1, 3.3.2)	Operations: CollectProcesses() CollectProcedures() CollectHistoricalInformation()

The high-level requirements are used to generate the detailed product and application requirements. Various product requirements of Training, Service, and Deployment are documented. Application requirements such as Functional, Quality, Content, Interface / data, and Security/Control are identified and documented along with technical architecture requirements. A requirement traceability matrix is created to keep track and manage them effectively as the project progresses.

A project may be divided into phases depending upon the project scale, duration and complexity. Therefore, rewriting the initiation processes at each phase may help to manage the project resources and stakeholders in a focussed manner. The entry and exit criterion are identified and approval to continue or discontinue the project is taken. Hence it gives better control of each phase and if the business need changes project can be stopped.

Every High-level requirement contains a number of parts; Current Capability Assessment, Product Requirements and Scope of the Project. Scope of the Project is dependent on cost, time, Project statement of work and the number of assumptions and constraints for the projects agreed by the stakeholders. Stakeholders approve the time, cost and scope the project which is used for monitoring and controlling the project.
Products requirements are based on the various Application requirements and Technical Architecture Requirements of the project which have been approved by the stakeholders. There is a Traceability Matrix, which can have horizontal, vertical or Bi-Directional traceability of the requirements from High level to product, Application, technical architecture and vice-versa.

5.1.1 Requirements Gathering in Global Scenario

For any project, product or a service requirement has to be gathered and defined for delivering the solution. The requirements capture the functional as well as non-functional requirements so that the project meets the customer needs and expectations.

Process of defining the requirements should follow producing, recording, confirming, evaluating, ranking, proving, and communicating the needs and expectations of the clients.

The requirements are established during the plan and analysis phases of the project and are recorded in the baseline scope in the requirement traceability matrix. The requirements can change as the project progresses with client expectation but should follow the change control and configuration management process.

- Planning Phase: Business requirements are gathered along with assumptions, constraints and client/ stakeholder expectations and needs.
- Analysis Phase: Business requirements are elaborated to develop product or project requirements in details along with test scenarios/ conditions/ scripts.
- Design Phase: Detailed product/ project requirements are developed along with functional and non-functional testing requirements.
- Development/ Build Phase: The product/ project is built to deliver the business requirements.
- Testing Phase: Testing is done to verify and validate the product against clients' needs and expectations. Unit testing, assembly testing, user acceptance testing, performance testing and deployment/ operation readiness tests are conducted to show case that the project/ product meets client needs and expectations.

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5.1.1.1 Business Requirements

Business requirements are gathered during the Planning phase. The requirements are detailed out as the project move from planning to implementation phases. The requirements can change during any phase. The changes must be controlled and follow the change control process and configuration management process so that correct prioritisation is followed. Requirement traceability process ensures that all the requirements are captured and scope is defined and baselined to define the measurement criterion for project success.

5.1.1.2 How to Capture Requirements

Requirements can be captured in the requirement traceability matrix by following the steps given below:

- **Producing.** Requirements from all stakeholders are identified and defend.
- **Recording.** All the requirements are captured in requirement traceability matrix so that they can be reviewed and signed-off.
- **Confirming.** All the requirements must be verified with the clients and signed-off.
- **Evaluating.** The client requirements are analysed and reviewed with the client for meeting the assumptions and constrains.

The requirements must be analysed for time/ cost/ risk/ scope / quality and effort.

- **Ranking.** The requirements must be prioritised to balance the time/ cost/ scope and meet client expectations and goals.
- **Proving.** The requirements must be validated with the client to baseline the scope and client expectations.

5.2 Project Planning Process Group

The main objective of the project plan is to establish the project within the Program Management Office and define the basic project structure. Project Plan should identify all stakeholders, and determine their needs, expectations, constraints, and interfaces for all the life cycle stages. Project Plan helps in estimating the overall level of effort, and creates a realistic and achievable plan that meets stakeholder goals and expectations. Project plan establishes the approach, technique, and tools to enable and support requirements traceability throughout the project life cycle.

An important part of the Project Plan is creating the deliverables necessary for the successful execution of future project stages. Planning documents must also be created that are specific to the Plan stage itself.

The Project Plan typically involves many stakeholders who produce a significant number of deliverables in a relatively short period of time. As such, plan and execute it using project management best practices. At the beginning of the Project Plan, create basic planning documents focusing on managing the stage with speed and efficiency. Other more detailed deliverables that support future project stages are subsequently completed as separate activities during the Plan stage. The end result is that during the Project Plan, two sets of planning documents are created:

- A set of basic planning documents that support the management of the Plan stage activities
- A more robust set of Project Plan deliverables that support the entire project throughout all remaining life cycle stages (e.g., Analyse through Deploy stages)

Project Plan defines high-level requirements and the scope of the application based on the vision and business objectives and also defines what is not in scope. Project Plan assesses the current capabilities of the organization in terms of business processes, applications, technology, and training and performance support. Then create a high-level design, or blueprint, for each area of the solution. Project Plan establishes a change plan to enable people and the organization to operate the new capability. Potential risks due to uncertainty with the solution's difficulty, complexity, and feasibility are also estimated. Project Plan defines the strategies for developing, testing, piloting, and deploying the application to the deployment unit.

Project Plan outlines the sourcing strategy to make sure the project has the right skills to deliver the application and using offshore delivery centres to meet the project's cost objective. Project Plan identifies the transition strategy for deliverable responsibilities from client-site team to development teams (off-site and/or offshore where applicable) and the new capability to the operations team. Commitment to proceed to the next work stage, and transition the outcome of the planning tasks to the team responsible for this work is done in the project plan.

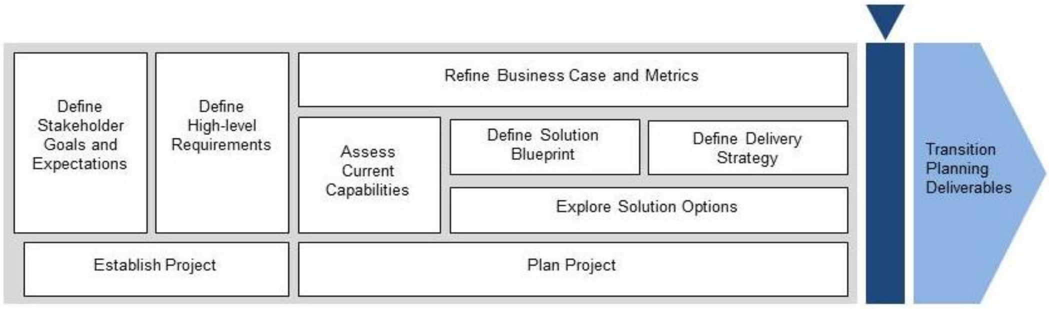


Figure 5.2 Project Plan flow

The planning process uses the information from different sources to develop a *ProjectManagementPlan (PMP)* class. The planning process helps to develop the complete project scope, cost, schedule, communication, and risk plans which have been identified in the initiation process. As the insight into the project grows, additional assumptions, constraints, dependencies are also documented. Since the projects are multi-dimensional in nature, the processes are to be repeated based on feedback and additional analysis. The large changes may affect the project time, cost, scope and hence the requirements may be rewritten and process ad planning will change accordingly. The frequency of iteration depends upon the nature and the need of change. The progressive detailing of the project management plan is also called 'rolling wave planning'.

All the stakeholders must be used in planning depending upon their influence on the project. Procedures and processes of the organisation would limit the number of iterations of feedback and refinement of plan.

The plan has to take into account the skills of people both management and technical skills and experience. The parameters for evaluation of performance are also defined. Various deliverables and documents are also generated.

The *PMP* class is associated with Scope, Cost, Time, Quality, Risk, and Communication management classes. In order to manage the Project effectively and efficiently various operation are to be performed which are defined as ManageSchedule(), ManageBudget(), ManageQuality(), and ManageRisk().

Scope class is already defined in the Project Initiation process above and is dependent on Time, cost and project statement of work. Project baselines are calculated in terms of cost and schedule.

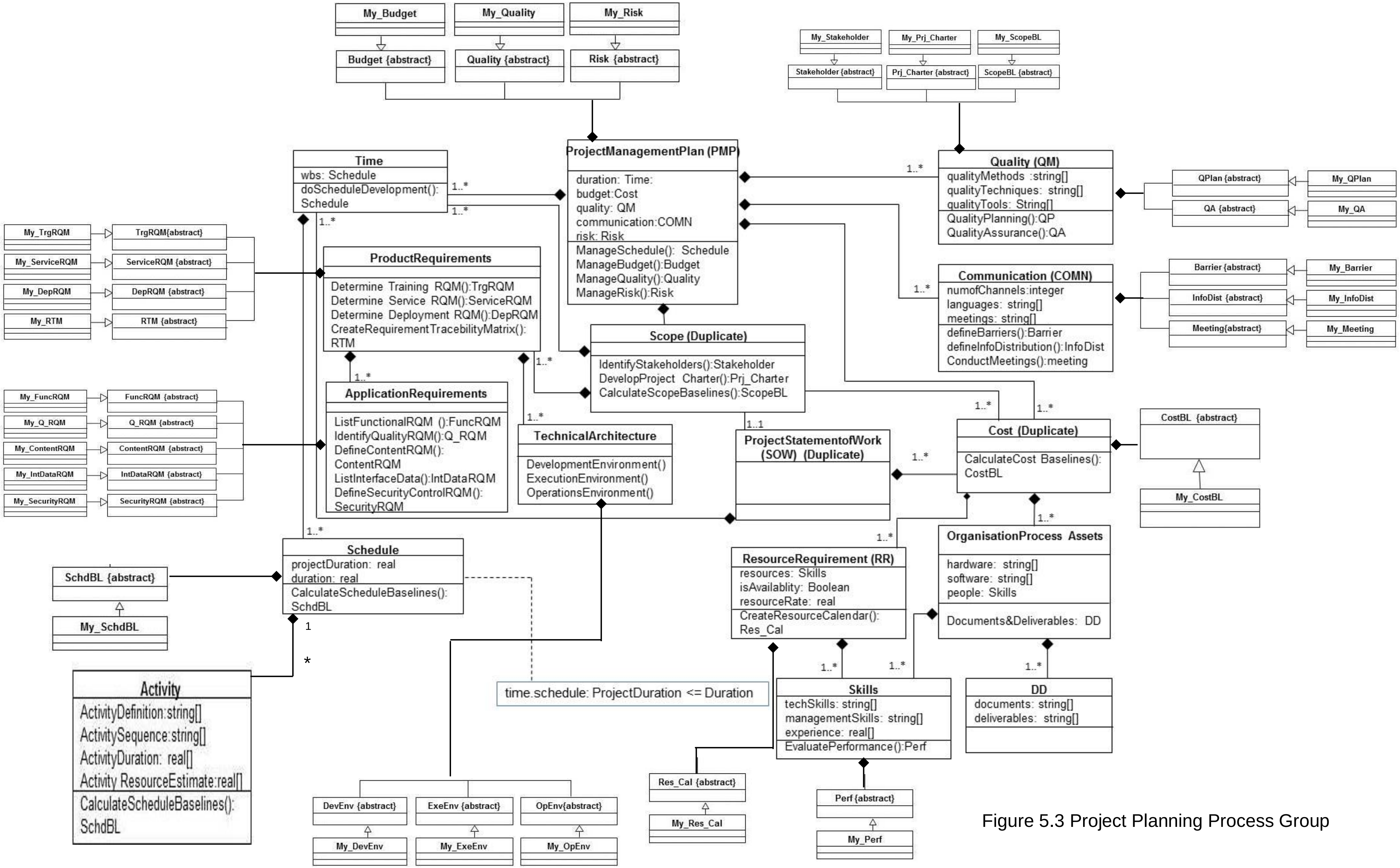


Figure 5.3 Project Planning Process Group

Duration of the project is calculated using the *Time* class. The schedule is developed based on Work Breakdown Structure (WBS) and also cost estimate is done based on activities and schedule. The WBS is calculated using *Schedule* class and performing ScheduleDevelopment() and ScheduleBaselines() operations. *Schedule* class has one attribute Project Duration and one CalculateScheduleBaselines operation. *Activity* class has five attributes to describe various activities and work to be done for completing the project. These are Activity Definition: task to be performed; Activity Sequencing: order and priority of task to be performed; ActivityDuration: the time to complete that particular task; and ActivityResourceEstimate: to number of resources required to complete the task. Baselines for the duration and time for the project are calculated using CalculateScheduleBaselines() operation.

Budget for the project is calculated using *Cost* class. This class has one attribute CostEstimate and one operation of CalculateCostBaselines(). The time for the completion of the project is estimated based on the *Time* Class and *ProjectStatementofWork* class, Organisation Process Assets class and *ResourceRequirement (RR)* class. This has attributes of Hardware, Software, Documents & Deliverables, and People required for completion of the project. The resources required for the project is calculated and the cost associated with the number of resources is also calculated. The resources are selected depending on their skills, availability for time constraints, and the cost impact on the available budget constraints of the project.

Quality(QM) plan class is based on the three attributes of selecting qualityMethods, qualityTools and qualityTechniques used. It has the operations of QualityPlanning() and QualityAssurance() which are to be agreed and approved by the stakeholders. Quality Methods can be selected based on the stakeholder and project needs e.g. TQM (Total Quality Management), Six Sigma, ISO, etc. Just in Time, Kaizen etc. Quality Control techniques could be any of the Cost-Benefit Analysis, Benchmarking, Design of Experiments, Cost of Quality and Cost of Poor Quality, etc. Quality Control tools such as Cause and Effect Diagram (also called Ishikawa diagrams), Control Charts, Flowcharting, Histogram, Pareto Chart, Run Chart, Scatter Diagram, Statistical Sampling, Inspection Defect Repair Review, etc. are used to perform quality control for the project.

The team should also define the communication plan based on the number of channels of communication, languages used, and meetings planned. The team should be able to define schedule based on activities, their sequencing, and activity resource estimating. The baseline for schedule is created. Communication plan also forms part of the PMP as this defines how often, which information, to whom, and the channels of communication and project management. *Communication(COMN)* class has three attributes NumofChannels, Languages to be used for communication, and the Meetings to depict the number of meetings to be held. Communication channels are dependent on the number of people in the communication plan. The communications methods can be Formal Written, Formal Verbal, Informal Written and

Informal Verbal. The non-verbal communication is also very important as approximately 55% of all communications are non-verbal (e.g. based on physical mannerisms, pitch, tone, volume, etc.). Therefore operation defineBarriers() is used to describe various barriers to communication. defineInfoDistribution() operation helps to send information to all the channels of communication after the meetings are conducted as per the requirements of ConductMeetings() operation.

Table 5.2 Project Planning Process Group mapping

PMBOK[1] processes and activities (section)	**Formalised Model**
Develop Project Management Plan (3.4.1)	ProjectManagementPlan (PMP) class
Create WBS and WBS dictionary (3.4.4)	Time Class WBS attribute
Activity Duration Estimating (3.4.7, 3..4.8)	Schedule Class CalculateScheduleBaselines() operation
Activity Sequencing (3.4.6)	ActivitySequencing() operation
Activity Definition (3.4.5)	ActivityDefinition() operation
Activity Resource Estimating (3.4.7)	ResourceRequirement(RR) Class ActivityResourceEstimate() operation Skills Class
Cost Estimating (3.4.10)	Cost Class
Cost Budgeting (3.4.11)	Cost Class
Human Resource Planning & Determine Team (3.4.13)	ResourceRequirement(RR) Class Skills class
Risk Management Planning (3.4.15 – 3.4.19)	ManageRisk() operation
Determine Communication Requirements (3.4.2, 3.4.14)	Communication (COMN) class
Scope Planning (3.4.3)	Scope Class ProductRequirements class ApplicationRequirements class TechnicalArchitecture class
Create Project Scope (3.4.3)	CalculateScopeBaselines() operation
Organisation Process Assets (3.4.1, 3.4.3)	OrganisationProcessAssets class DocumentDeliverables(DD) class
Develop Schedule (3.4.9)	ScheduleDevelopment() operation
Estimate Resource Requirements (3.4.2, 3.4.13)	CreateResourceCalendar() operation
Quality Planning (3.4.12)	Quality (QM) class
Determine Quality, Standards, Processes & Metrics (3.4.12)	Quality (QM) class QualityPlanning() operation QualityAssurance() operation

Unless the project is straightforward, the overall process of estimating, scheduling, and levelling resource requires multiple iterations. For example, detailed estimate, schedule, and plan project financials are performed iteratively with determining resource needs during Project Plan until the resource types in the project are accurately identified and levelled.

In addition to being performed at the start of the project, these tasks can also be performed as needed (typically at key milestones) to revise and further detail the Project Plan to reflect changes to future project stages, re-planning based on performance assessment outcomes, or other authorized project changes. Lastly, confirm that as the Project Plan changes, it continues to align with the organisation plan and objectives. Project Plan should be refined at the end of each stage (Analyse, Design, Build, and Test) and after each iteration.

Project Planning establishes estimates, develops and maintains plans, and obtains commitment to the defined project activities. This results in projects with clear, measurable direction and guidance.

Planning includes estimating the complexity of the work products and duration of tasks, determining resources needs, involving stakeholders and obtaining commitments, developing a schedule and budget, adapting project management processes, and identifying and analysing project risks. Planning data includes the scope, project life cycle, work products and tasks, effort and cost estimates. Projects can leverage the organisation-wide best practices, standards, templates, and estimating tools (based on historical data) in planning and estimating.

Project planning also includes planning for schedule, effort, critical resources, cost, quality management, scope management, configuration management, data management, issue management, risk management, communication, measurement and metrics, training, tracking and status reporting, decision analysis and resolution, supplier agreements, verification, and all development and maintenance activities.

5.3 Project Executing Process Group

The executing process consists of processes used to complete the work and activities defined in the project management plan. The project team is acquired and criteria for awards and recognition is also defined. The team takes approval from the appropriate stakeholders for the works and tasks to be performed. Team should hold regular progress meetings in order to see the project progress and take appropriate actions.

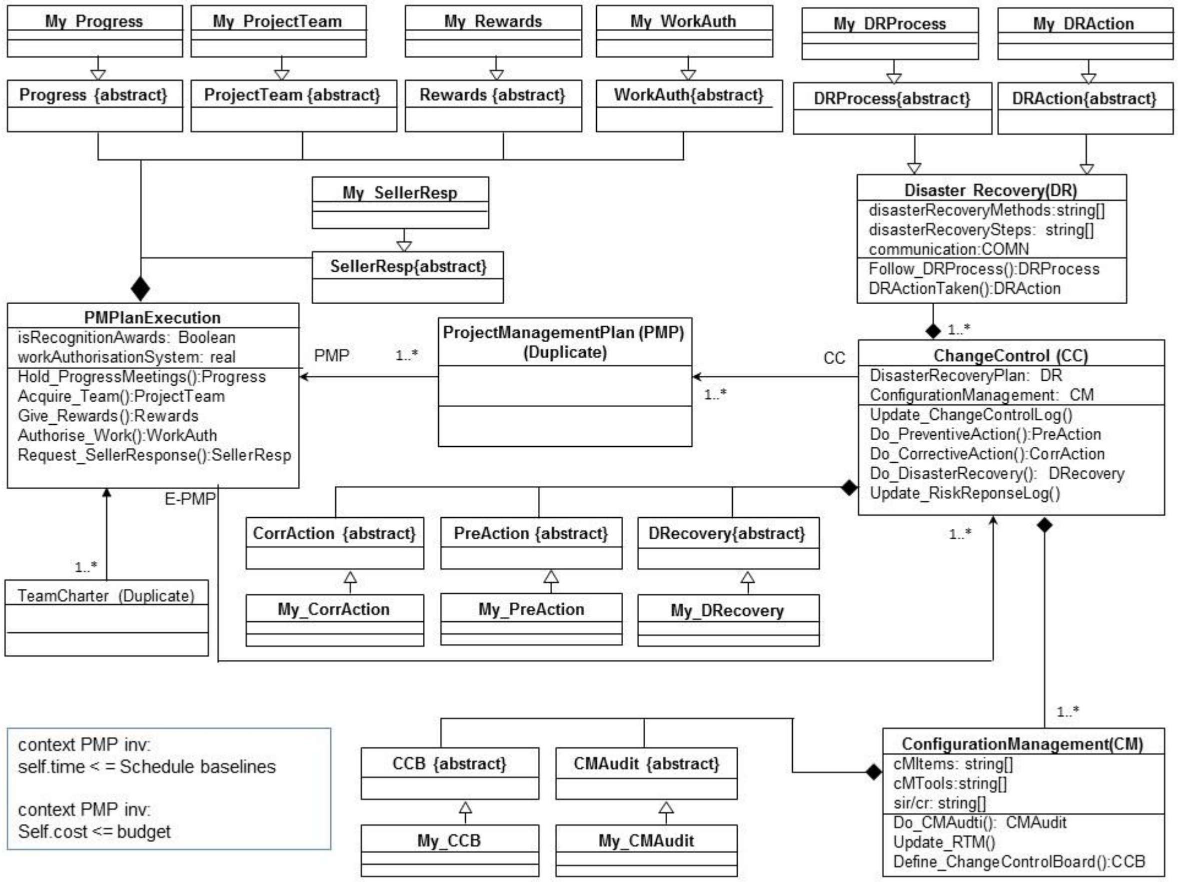


Figure 5.4 Project Executing Process Group

The team considers variances in schedule and cost project re-planning is done with the approval of appropriate stakeholders. Team follows the change control processes taking into consideration configuration management and disaster recovery processes. Team defines and takes appropriate preventive and corrective actions for managing the project efficiently as per the project management plan.

The *ChangeControl (CC)* class is associated with *ConfigurationManagement(CM)* class and DisasterRecovery(DR) plan class. Change Control is done as per the Change Control processes and procedures. This is used to update the ChangeControlLog() to see the changes done; Any preventive or corrective actions are taken using PreventiveAction() and

CorrectiveAction(). The Risk Response log is also updated to manage risks and issues effectively.

The *DisasterRecovery(DR)* class is based on the DisasterRecoveryMethods, DisasterRecoverySteps, and the Communication plans. Disaster Recovery is performed using the FollowDRPocess() and DRActionTaken() operations.

The Configuration management defines various system instance reports/ change requests received. The plan incorporates various preventive and corrective actions to be taken. *ConfigurationManagement(CM)* class has three attributes of CMItems: to define the tasks covered; CMTools: to define the tools used for configuration management; SIR/CR: for defining system instance reports and change requests received for the project/ task. Team has to perform CMAudits(): auditing the change; UpdateRTM(): reviewing and updating the requirements traceability matrix. The changes are to be performed as approved by the members in the list creating using Define_ChangeControBoard() operation.

The *PMPlanExecution (E-PMP)* class has two attributes of isRecognition&Rewards WorkAuthorisationSystem. Project Management Plan is executed and performing meetings as per the operations defined; Hold_ProgressMeetings(); Acquire_Team(): to get the team members for performing the project work; Give_Rewards(): to evaluate performance and give rewards to the good performers as per the approved criteria; Authorise Work(): to allocate the tasks as per the approved plan. The variances in the schedule and budget are evaluated and appropriate preventive or corrective actions taken to manage the project on time and on budget.

Table 5.3 Project Executing Process Group mapping

PMBOK[1] processes and activities (section)	**Formalised Model**
Direct and Manage Project Execution (3.5.1, 3.5.7)	PMPlanExecution class Operation: Hold_ProgressMeetings()
Perform Quality Assurance (3.5.2)	Operation: Manage_Quality() Update_ChangeControlLog()
Acquire Final Project Team (3.5.3)	Acquire_Team() operation
Give recognition & Rewards (3.5.5)	Give_Rewards() operation
Implement Changes, defect repair, preventive and corrective action (3.5.2)	Change Control class Operations: Do_PreventiveAction() Do_CorrectiveAction()

PMBOK[1] processes and activities (section)	**Formalised Model**
	Do_DisasterRecovery()
Information Distribution (3.5.6, 3.5.7)	communication (COMN) attribute Operations: Update RTM Do_CMAudits() Define_ChangeControlBoard() Update RiskResponseLog()
Request Seller Response (3.5.8)	Request_SellerResponse() operation
Select Seller (3.5.8)	Authorise_Work() operation
Continuous Improvement (3.5.2)	ChangeControl class ConfigurationManagement (CM) class

The project is to be executed as per the plan and managed as defined in the monitoring and control process. The team and individual are acquired for the work and work authorised. Performances are evaluated and awards given.

5.3.1 Gather Team Status and Metrics Data

With reference to the Direct and Manage Project Execution (3.5.1, 3.5.7) activities defined in Table 5.3, gather Team Status and Metrics Data involves the following:

- Collect Team documents, individual Status Report, team Status Report, and information from project management tools and deliverables to get status information.
- Track actuals; schedule, resource, effort, budget or financials against the Work Plan.
  - Track actuals and identify variance between planned vs. actual hours spent on tasks.
  - Identify tasks that are over budget or past due. Highlight tasks that are over budget or past due in the Status Reports.
  - Track financials. If cost rates are already in the Work Plan, use the Work Plan to track costs. Otherwise, see project financial tracking sheet to obtain the financial data.
- Capture metrics data as outlined in the Project Measurement Plan. Gather metrics data from project reporting documents such as turnaround documents (T-Doc), individual and team project status reports, project financial report, peer review feedback, SIR and change requests, risk management tool and other sources. Enter data in the measurement reporting tool. The core set of metrics include:
  - Cost Performance Index - Effort (CPI)
  - Schedule Performance Index - Effort (SPI)
  - Peer Review Efficiency
  - Peer Review Problem Detection

    - Resolution Time Performance
    - Response Time Performance

Consider using a measurement reporting tool to track project execution.

5.3.1.1 Analyze Metrics and Report Project Status

Analyze metrics to understand the progress of the project and how efficiently and effectively the work effort meets the project objectives and the stakeholder expectations. Use the Project Measurement Plan to understand how the metrics will be analyzed and reported as per the Perform Quality Assurance (3.5.2) activities of Table 5.3.

This step involves the following:

- Check the quality of the data. The quality of the analysis and the ability for decision makers to trust the analysis is dependent on the quality of the data. Some of the criteria considered essential are consistent data in types and categories, accurate data and data with a consistent unit of measures.
- Analyze metrics for trends, inconsistencies, out-of-bounds data values, and reasonableness at least twice a month. Analyze and determine causes for those metrics with results outside the specification limits or those with trending or one-sided results. The project manager should discuss and develop an action plan to address those causes.
- Analyze the interrelationships among the metrics gathered for indirect project impacts.
- Monitor progress and performance metrics on an ongoing basis. The project manager uses the measurement reporting tool.
- Report project status and measurement and analysis results to all relevant stakeholders in a timely fashion to support accurate assessment of status, decision making and corrective action. Document project status using the project status report template for the Status Report. Monitor project commitments against those identified in the project plan.
- Conduct status meetings to communicate project status, issues, and metrics analysis to the appropriate level of management and stakeholders and create meeting minutes. Stakeholders include project team members, client, and other people external to the team (vendor, subcontractor, contract management, etc.).

When actual status deviates from the plan, the project manager needs to take the appropriate steps to get the project back on track. The project manager identifies the corrective actions, and tracks them through closure. If the Work Plan needs to be updated, the project manager goes through the appropriate configuration management process as defined in the Configuration Management Plan.

5.3.2 Determine Resource Needs

The process of estimating, scheduling, determining resources, planning financials, and documenting assumptions and risks is iterative. Perform this step iteratively and in conjunction with generating Detailed Work Estimate, documenting Assumptions and Risks, and developing Management Plans which is corresponding to Acquire Final Project Team (3.5.3) activities defined in the Table 5.3.

Complex projects create a Resource Plan to aid in the planning process. For projects of limited resource complexity, the Resource Plan is optional. Microsoft Project, may be sufficient for simple personnel resource planning. Additionally, projects with limited other, non-personnel resource complexity can use the Logistics and Infrastructure section of the Project Plan to record non-personnel resources. The remainder of this step assumes the development of a Resource Plan.

Determine the types of roles and associated knowledge and skills needed to perform the estimated work. Use the output from the estimator as a starting point. For each type of role, roughly determine the number of resources needed to complete the estimated work based on the estimated time required and project time frame. Load this high-level resource estimate into the Resource Plan and Work Plan.

Consider using resources from other workgroups within the company, onshore/offshore delivery centre personnel, client personnel, and third parties to fill the identified roles.

Document the resulting workforce mix in the Project Plan, Resource Plan, and Work Plan. Program management subsequently reviews, approves, and acts on these resource needs. After determining the project resource needs, develop the project organizational chart contained within the Project Plan. This chart is a hierarchical breakdown of the project team that shows primary reporting responsibilities and lines of authority. The team organization reflects proper consideration and balancing of the following factors:

- Type of work. Aggregate tasks with similar skill requirements. Assign related work requiring complex integration to a minimum number of people to reduce coordination and integration issues. Assign highly skilled, specialized work to a minimum number of people to reduce the need for deeply skilled team members.
- Team size and internal structure. Aggregate closely related work within teams, and recognize the span of control limits. Consider using work cells, high-performance teams, and other team approaches to reduce the number of deliverable hand-offs and to provide clear ownership of the deliverables created. For example, work cells are work groups that include individuals who are responsible for producing a significant deliverable, contain all of the skills and resources needed to perform their assigned work, and are located close together.

After determining the needed resources and the project organization, use the Work Plan and Resource Plan to perform detailed resource loading by completing the following:

- Establish a time period (e.g., week, month, etc.) for allocating the estimated resources.
- Allocate the resources to the time periods by role/type/skill. Allocate resources at less than 100% of the available time for project activities to enable participation in non-project activities like community meetings, recruiting, mentoring, training, vacation, etc.
- Level the resource loads to eliminate or reduce the peaks and valleys for the estimated work by adjusting task duration, adjusting staffing levels, creating new work packages, revising resource estimates, re-sequencing work packages, creating new work packages, and/or revising the schedule and milestones if necessary.
- Update the affected plans as necessary based on the extent of changes required during resource loading (e.g., new milestones, revised schedule, change in the distributed work model, etc.)
- Communicate significant adjustments to program management. Changes can affect the program-level milestones, effort/cost, and the need for workspace and support resources.

In addition to determining the workforce needs, ensure the project has the appropriate facilities and tools to do the job by determining the project's physical resource needs. For example, this can include office work space, conference rooms, computers, servers, network connectivity, printers, software, phones, office supplies, etc. Consider the lead times to acquire physical resources, and begin the procurement process, if applicable.

Consider additional physical resource needs associated with a distributed workforce, if applicable. For example, these additional resource needs can include infrastructure, facilities, technical environments, communications needs, etc. Identify and document the high-level description, quantity needed, and dates needed as appropriate in the Resource Plan for physical resources. If known, document the additional details for items procurement in the Procurement Plan. For more information on procuring non-personnel resources, see the Organize Project Resource step.

The primary outputs of this step are the Resource Plan (documents the project resource requirements at a high level), the project organizational chart contained within the Project Plan (updated if more or fewer resources are needed), the Project Schedule and Milestones and the Deliverables/Milestones sections of the Project Plan (if milestones changed), and the Work Plan (updated with detailed resource requirements).

5.3.3 Organize Project Resources

This step describes the initial organization of project resources. The primary outputs of this step include an updated project organizational chart contained within the Project Plan, Roles and Responsibilities, Work Plan, Procurement Plan, and a Team Charter for each team in the project.

The project should use the project organizational chart to document the integrated team structure that best meets the project objectives and constraints. This structure could be many teams for large projects or just one team for very small projects. Document the team structure in the project organizational chart contained within the Project Plan.

Based on the specific knowledge, skills, and availability of the team resources provided by project management, determine the integrated team structure that best meets the project objectives and constraints. The project team must perform a preliminary distribution of requirements, responsibilities, authorities, tasks, and interfaces to integrated teams using the Team Charter and high-level requirements from the Requirements Traceability Matrix.

Establish and maintain a Team Charter based on the integrated team's shared vision and overall team objectives. Each team needs to develop a Team Charter. Keep in mind the following points when developing a Team Charter:

- Define the team's vision in the Team Charter. Define a shared vision for the integrated team that is aligned with any overarching or higher-level vision (e.g., organizational, program, etc).
- Assign team members with the right knowledge and skills to the appropriate tasks in the Work Plan. Document these assignments in the Team Charter.
- Clearly define and maintain each team member's roles and responsibilities within the Team Charter.
- Define integrated team operating procedures within the Team Charter.
- Define interfaces and collaboration among teams within the Team Charter.
- Based on the Team Charter, adjust the Work Plan to reflect actual staffing and availability.
- Based on the Team Charter, update resource needs with project management to show actual resources obtained and any resources still required.

Document the roles and responsibilities by creating a bulleted list of the duties that a resource in a specified role must perform. Create clear and easily measurable responsibilities. Include activities related to both project management (e.g., status reporting, issue/risk management, team building, and knowledge management) and traditional application development tasks as appropriate. Include time frames (e.g., daily, weekly), any tools to use, and the required technical proficiencies. Review the roles and expectations with the team member. This information can be used as an input to the performance feedback process.

Select and staff team members through the following steps:

- Program management identifies potential team candidates based on role descriptions in the Resource Plan and Security Plan.

- The project manager and/or appropriate project team lead interviews and selects the team members from these candidates and advises program management of the selections.
- Program management arranges for the selected persons to be assigned to the project.
- Update the project organizational chart with the names of the actual resources who fill the identified roles.

The hardware and software procurement process can be cumbersome and time consuming; plan for it as soon as possible. Create an initial Procurement Plan to document the physical resources (e.g. facilities, computers, network, phones, etc.) and the process to acquire them. The goal is that the project obtains what it needs at the time it is needed and minimizes the risk of project delay. When planning, complete the following:

- Identify all the hardware and software products to procure. Use information from the Technology Capacity Plan for initial hardware and software requirements.
- Determine when each product is needed. Review the Resource Plan as a high-level input, and assess when each product is needed. Confirm that the Resource Plan aligns with the Work Plan and Technology Implementation Plan.
- Determine who manages the procurement process when the person is responsible for tracking the order and ensuring it is received by the right team.
- Determine when to write and submit the purchase order. Ask other programs and projects about the delivery reliability of each vendor. The plan considers the typical delivery behaviour of each vendor before deciding when to submit the purchase order. Build extra time in the Procurement Plan to ensure the product is available when needed.
- Identify where requests are sent.
- Determine who is responsible for each product to be purchased.
- Determine who approves the order.
- Determine who receives each product.
- Determine who tests the products when they arrive. Inspect and test each product before using it for the project.
- Define support requirements.

Ensure the Work Plan allocates time for the project team members to test the hardware/software and resolve issues as they arise. Document the risks associated with the procurement process, and manage them accordingly.

The primary outputs of this step include an updated project organizational chart contained within the Project Plan, Roles and Responsibilities, Work Plan, and Procurement Plan.

5.3.4 Manage Issues

Follow the Issue Management Plan for tracking and managing project issues which corresponds to Implement Changes, defect repair, preventive and corrective action (3.5.2) activities of Table 5.3. Issue Management Plan defines the process for the identifying, analyzing, resolving, reporting, and escalating project issues to higher-level management of the project. Use the project issue management tool or Issue Log, to track and manage issues. Project should track, at a minimum, the nature of the issue, as well as the impact, priority, status, and resolution.

Project issue analysis and resolution is considered a formal decision process. Use the Decision Analysis and Resolution Report to document the selection criteria and summarize the results.

5.3.4.1 Manage Risks

Risk Management is the recognition, assessment and control of uncertainties that may result in schedule delays, cost overruns, performance problems, adverse environmental impacts or other undesired consequences. Risk tracking is the actual process by which a project team monitors and controls identified risks. Track risks in the project risk management tool or Risk Log. Discuss project risks with the appropriate stakeholders at least monthly during status meetings. Make risks and risk mitigation a standing item on a status meeting agenda. Risk category discussion includes, but is not limited to the following:

- External
- Internal
- Operational
- Contractual
- Financial

Bring in all the appropriate stakeholders and resources as required when discussing a specific risk category.

The project must follow the Risk Management Plan, and use the Risk Log for tracking and managing risks.

Other documents to use for this process:

- Risk Management procedures category, which contains detailed procedures for risk management.

Project risk assessment and control is considered a formal decision process. See the Project Plan and the Decision Analysis and Resolution Guidelines to understand how to perform the DAR process. Use the Decision Analysis and Resolution Report to document the selection criteria and summarize the results.

5.3.4.2 Determine Alternatives and Perform Corrective Actions

At any point during the project life cycle, project leadership needs to make decisions on issue resolution or further direction.

Manage corrective actions until the issue is closed. The steps include:

- Identify and analyze alternatives.
- Prioritize alternatives based on cost and impact.
- Decide and obtain agreement on the appropriate resolution.
- Monitor corrective action to completion.

Action items can lead to issues and risks that need to be tracked to closure. Use the Issue Log and Risk Log to track issues and risks. Work with the PMO to resolve any issues or risks that affect the project's ability to meet the expected Business Case value or benefits.

5.3.5 Change Control Board (CCB)

Although the configuration manager has overall responsibility for CM at the project site, establish a change control board (CCB) to evaluate and authorize the changes to the system components identified as configuration items. This corresponds to Information Distribution (3.5.6, 3.5.7) activities defined in Table 5.3. The CCB can manage the project's baselines.
The CCB has the following responsibilities:

- Authorize the establishment of baselines and the identification of configuration items.
- Monitor changes and updates to project requirements as part of CM.
- Represent the interests of the project manager and any groups affected by baseline changes (e.g., software engineering, system engineering, system test, software quality assurance, etc.).
- Review and authorize baseline changes.
- Authorize product creation from the CM library.
- Establish, document, and communicate the criteria that evaluates the CICRs.
- Review the Configuration Management Plan.
- Review and approve all new baselines.
- Create and communicate CCB meeting minutes to affected groups.

5.3.5.1 Change Control Board Members

The CCB consists of members that represent each discipline and groups affected by changes to the configuration items. If the project does not have a CCB, reference the group or person responsible for performing the CCB activities.

5.3.5.2 Change Control Board Schedule

The CCB meets on a regular basis at the same time in a designated location. Make this information available in the Configuration Management Plan.

5.3.5.3 Maintain Stakeholder Involvement

Project stakeholders include representatives from both technical and functional teams, customers, suppliers, and other stakeholders outside of the organization involved with the project (vendor, subcontractor, etc). The Stakeholder Goals and Expectations and the Project Plan define the relevant project stakeholders, their roles, and their expected involvement in each stage. Stakeholder Goals and Expectations establishes the ground rules by which the stakeholder expectations should be managed. The quality of stakeholder involvement contributes to the project's ability to meet stakeholder expectations. Proactively manage stakeholder interfacing and interactions. Ensure the appropriate interfacing is taking place between all relevant stakeholders. Especially, involve the stakeholders in:

- Defining and tracking critical dependencies
- Identifying and resolving issues and risks
- Decision analysis and resolution
- Review and sign-off of key project tasks and deliverables

Conduct periodic status and milestone review meetings to engage stakeholders and increase their level of ownership and commitment to the project. Milestone reviews should be performed at "Confirm" points throughout the methods. Example; Confirm Planning Deliverables, Application Analysis Deliverables, Confirm Application Design Deliverables, etc. Review status of project commitments against those identified in the project plan. Document meeting result and action items in the Review Documentation.

If program management is present, collaborate with program management in managing stakeholder interactions.

5.3.5.4 Perform Re-planning at Key Milestones and Scope Changes

Project leadership conducted the original planning and estimating process during the Plan stage. Planning, however, is an iterative effort that is typically performed at key milestones and at scope changes. Performance data captured in the Project Management Reports provide indicators on the need to re-plan. Re-planning includes re-estimating of work effort, resource needs, completion schedule, and other cost figures. The Project Plan will need to be updated once re-planning is completed and changes are approved.

Continue to monitor the project's progress toward the Business Case's values or benefits. Review the Project Statement of Work and Solution Metrics to understand where you expect to be against the Business Case. Analyze any changes to understand the potential effect on your project metrics and Business Case. Work with the PMO to correct any inconsistencies in the way benefits have been assigned to your project. Communicate any additional opportunities identified for maximizing value.

5.3.5.5 Audits

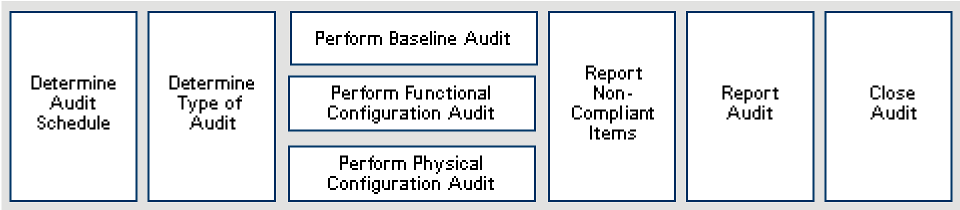


Figure 5.5 Audit

The configuration manager (or CM team) co-chairs, with the client, the formal CM audits: the functional configuration audit and physical configuration audit.

5.3.5.6 Audit Types

Audits verify consistency between the products and their associated documentation. Configuration audits verify that the required product attributes (performance requirements and functional constraints) are achieved and the design is accurately documented.

The most common types of audits include Baseline, Functional Configuration, Physical Configuration, and Library.

- Baseline Audit. This is typically conducted by individuals on the project prior to each new baseline that is established or before releasing a baseline into a new environment.
- Functional Configuration Audit (FCA). This ensures the integrity of the requirements by cross-referencing audit items to the requirements from which they were generated.
- Physical Configuration Audit (PCA). This ensures the integrity of the CM baselines, configuration items, and tools used to implement CM by verifying that all items identified as part of the configuration are present. The PCA also establishes that the correct version of each part of baseline is included.
- Library Audit. This optional audit ensures the verification of content in a CM-controlled library, and it is typically conducted by the CM team. In addition, the audit ensures the library's integrity (completeness, correctness, and consistency).

When auditing a CM library tool, the project completes the following:

- Assess the baseline's integrity.
- Review the structure and facilities of the CM library tool.
- Verify the correctness and completeness of the baseline contents.
- Verify that changes to the baseline were implemented as intended.
- Verify compliance with CM processes and procedures.

Note that library audits are often a requirement for Sarbanes Oxley compliance.

5.3.5.7 Baseline Audits

The frequency of the baseline audits depends on the project's size and duration. Perform a successful baseline audit before each new baseline change. This may coincide with the project's stages (e.g., development, string test, system test, integration test).

During the different project stages, individual project members perform informal baseline audits of the CM process to ensure the project follows the processes and procedures in the Configuration Management Plan. An independent assurance party (e.g., configuration manager, PI liaison, etc.) could also conduct additional baseline audits to ensure the project is missing nothing.

Perform a baseline audit prior to key checkpoints (entry and exit criteria) in each development stage and before making every baseline change. Take a new baseline only if the audit results succeed. In either case, the project ensures an adequate amount of time to prepare for a baseline audit.

5.3.5.8 Functional Configuration Audit (FCA)

A Functional Configuration Audit (FCA) verifies that the actual performance of the CI(s) meets the requirements stated in its performance specification and certifies that the CI(s) has met those requirements. This is a formal audit required at the end of all testing, just before deployment into a production environment.

For example, a user acceptance test (UAT) and Requirements Traceability Matrix can satisfy an FCA if the UAT test plans trace back to all actual performance requirements.
Results from other testing efforts (e.g., system test) may also be used as evidence for a FAC. In addition, the configuration manager needs to verify the following activities completed properly before releasing the product into production and/or to the client for an FCA:

- All deliverable code validates against the approved Requirements Traceability Matrix.
- All deliverable code validates against the approved design documents and test plans.
- Any deliverable or non-deliverable documents placed under CM control are updated properly.

5.3.5.9 Physical Configuration Audit (PCA)

A Physical Configuration Audit (PCA) examines the actual configuration of the CI that is representative of the product configuration, verifying the related design documentation matches the design of the deliverable CI.

The PCA occurs for each product baseline change and may also establish the product baseline. For example, a UAT, Requirements Traceability Matrix, and tests scripts (e.g., component, assembly, development architecture, product, etc.) can satisfy a PCA if the test scripts trace back to all the actual configuration requirements. In addition, the configuration manager needs to ensure the following activities were properly completed just before the product releases into production and/or to the client for a PCA:

- All CIs were physically identified.
- All Change Requests or System Investigation Requests open against any CI were reviewed and are in an appropriate status (e.g., closed, deferred, rejected).
- Ensure all CIs physically follows the standards specified in the Configuration Management Plan.
- A Configuration Management Status Report tracks any open issues/violations of PCA criteria or the Configuration Management Plan.

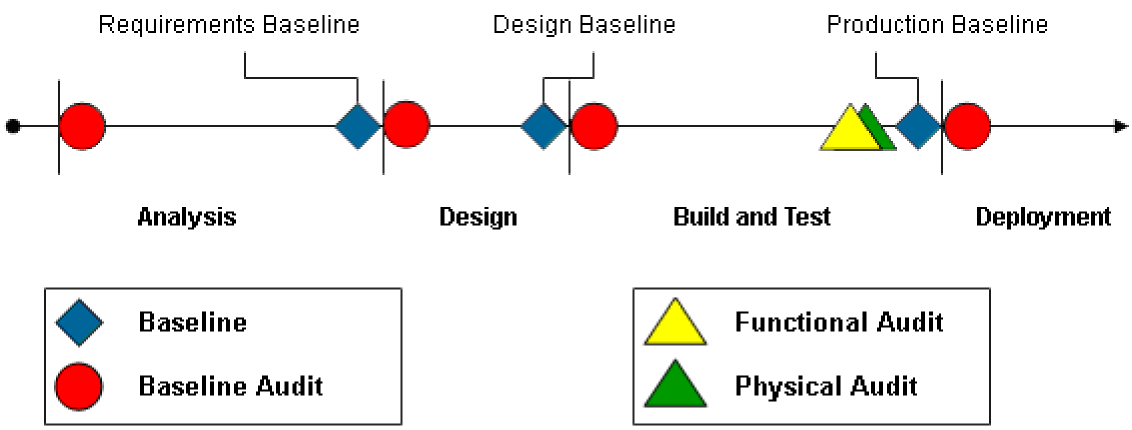


Figure 5.6 Audit Timeline

5.3.5.10 Reporting of Audits

Report the results of each audit to the project manager and any other necessary parties. The configuration manager ensures all action items are tracked until closure and reports on the status of the action items to the project manager.

5.3.5.11 Closing of Audits

An example that demonstrates that audits were effectively closed may include the following test:

“Audits will be closed once all the identified discrepancy are resolved.

Once all discrepancy items are resolved in the appropriate meeting, the configuration manager closes the audit by updating the audit report with a status of Closed status. The final audit is sent to all team leads and noted as 100% complete in the project’s Work Plan. The audit is stored as a configurable item in the CM library.”

5.3.5.12 Configuration Status Accounting

Configuration Status Accounting (CSA) is the process of recording, monitoring, and reporting all changes to established CIs. It verifies that project team members and other stakeholders are made aware of changes to these established CIs. Specifically, CSA profiles the following information for each change made to a CI:

- Description of the change/problem
- Impact analysis of the change/problem
- Status of the Change Request/System Investigation Report
- Name of implementer of the change/fix

CSA plays a key role in the success of medium to large development/maintenance programs. CSA provides the necessary coordination to ensure each program team is aware of changes/fixes being made by other program teams. The inter-team coordination helps ensure the full impact of a proposed change/fix is investigated and communicated to all affected program teams prior to being approved for implementation.

CSA also refers to the record keeping function of CM. CSA exists to provide all the technical information about the project system's configuration (e.g., hardware, software, and documentation) and the change history of the project's system.

The CM group (configuration manager and CM team) are responsible for the following CSA activities:

- Provide CI status to the project manager.
- Provide CM measures to the project manager.
- Provide a list of all CIs contained in a baseline, release, and CM controlled repository.
- Provide change history documentation for CIs as needed.

5.3.5.13 Configuration Management Status Reporting

To provide high-level insight into the overall status of CM activities to the project management, report CM status on a regular basis. Project management reviews the CM status and takes necessary action to resolve potential issues. If necessary, escalate CM issues to the client director.

The project selects a means of communicating CM status that is appropriate for its size, the number of CM resources, the development phase/stage, and the level of CM risk. The project documents the format and schedule for CM status reporting in the project's Configuration Management Plan. CM status reporting can be conducted in one or several of the following ways:

- Baseline creation reports. A project may opt to publish a schedule of when baselines should be taken, and then provide communications to interested teams when such baselines were performed. This type of report may be useful in letting development teams know when a certain baseline is available for continued development or testing.
- Change Request/System Investigation Request reports. These reports may come out of CCB meetings, System Investigation Request meetings, or may be produced at regular intervals by the team responsible. Include information such as the number of

Change Requests/System Investigation Requests opened, closed, and rejected within a certain period; the cumulative impact of approved Change Requests, the proposed release date of approved changes, and aging of Change Requests/System Investigation Requests.

- Audit results. Results of configuration audits may be communicated to the interested parties. Include information such as the number of issues discovered and the impact and disposition of such issues.
- Tech team status reports. The regular status reports of the team or individual who owns CM activities can be considered part of the CM status reporting approach if it includes relevant CM activities.
- Readiness to proceed. All Change Requests and System Investigation Requests that address known issues in a release must be either closed or deferred prior to releasing the baseline for additional work. A report on the readiness to proceed may be created to provide an account of the disposition of all relevant Change Requests and System Investigation Requests to ensure all are handled appropriately before moving forward.
- CM tool automated report. The CM tool may be the best source for an accurate accounting of the status of each CI. However, any automated report is only as good as the data that reside in the tool. Conduct audits on any CI accounting from a tool with the known Change Requests and System Investigation Requests that apply.
- Configuration Management Status Report. The project may choose to create a regular Configuration Management Status Report using another format.

Projects do not need to do all of the following, but they at least do one of the following and document in their Configuration Management Plan to track status by doing the selected option or options. Configuration management status reporting includes the following information:

- Resource use as compared to estimate
- CM conflicts or issues
- Dependency between groups
- CM risks
- Action items on the reports until they close

5.3.5.14 Configuration Item (CI) Status Reporting

CI status reporting is part of CM status reporting. It consists of in-depth status accounting of the entire project's CIs and is the record keeping function of CM. CI status is compiled and distributed according to the project-defined schedule, which is defined in the project's Configuration Management Plan. If necessary, escalate issues identified in CI status reporting to senior and/or project management for resolution.

By reviewing the status of CIs on a regular basis, the configuration manager can determine how the CM program is progressing in relation to documentation required, baselines established, changes, and the rate at which changes are occurring. Review the type of changes, reasons for changes, and cost of changes scheduled.

Like all CM status reporting, CI status reporting can be conducted by a variety of means. The project may choose any means of CI status reporting it deems appropriate.

CI status reporting includes tracking the following information against the Configuration Management Plan and CM baselines:

- Time when each baseline is established
- Time when each CI was included in the baseline
- Description of each CI
- Status of each CI-related change
- Description of the change to the CI
- Documentation status of each baseline
- Changes planned for each identified future baseline

Confirm supplier business relationships as described in the Request Seller Response (3.5.8) activities in Table 5.3 through the following:

- Use the company's standard procurement organization and procedures based on the project's location for contractors (e.g., Contractor Exchange in the US, Contractor Connection in Canada) and leveraging company's vendor alliances.
- Create formal agreements with suppliers.
- Use the Supplier Management Plan as the basis for how you will work with the vendors or third-party contractors on the project.
- Ensure the suppliers review and provide their input into the Project Plan, creating buy-in into the plan and commitment to its successful completion.
- Ensure you and the supplier agree on performance measurement, analysis, and reporting requirements. Include both project-specific and vendor-specific requirements.
- Understand your responsibility to the Program Management Office (PMO) for verification of any supplier billing.

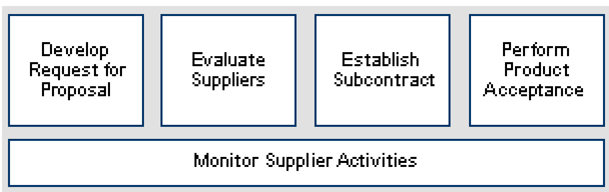


Figure 5.7 Supplier management

5.3.5.15 Develop Request for Proposal

Develop Request for Proposal (RFP) if suppliers have not been selected when the project started or if the project decides to subcontract specific services after the project has started. If the project has already identified only one supplier they plan to contract with (a.k.a. "sole-source") then this step can be omitted.

Third party agreements are separated into the following categories:
Third Party Software, Hardware, and Related Services
This section covers:

- Hardware
- Software license agreement
- Software upgrade/maintenance
- Hardware maintenance
- Technical professional services for hardware installation or training

When selecting third party software, hardware, and related services, follow an orderly and systematic approach to identify and select products to find the "best fit" and "best value." The Product Selection Approach provides an method that will:

- Identify and list viable products from the marketplace
- Narrow the list of finalists based on screen criteria
- Select the best solution for the project using comprehensive questionnaires and business scenarios

5.3.5.16 Subcontracts for Services

Subcontracts for services cover professional services to deliver part of the solution as required by the prime contract.

Assess the list of approved suppliers against the subcontractor selection criteria to select a subcontractor for the project. Some selection criteria will be generic (such as quality, service, value, past performance); however, there is greater value in defining specific criteria (especially those concerning longer-term cost considerations) that apply to different categories of services to be procured. Selection criteria should also reflect defined business needs.

5.3.5.17 Temporary Agencies and other independent contractors

For temporary agencies and other independent contractors each country has its own approach.

The project manager assesses the need to acquire products/services based on the requests from the technical architects and team leads (sometimes in the form of a Procurement Plan) and approves as necessary. Approval of the request for products/services will depend on technical and financial considerations, the type of services deemed critical for the project, and the cost of the products/services to be procured.

If there is a central technical support team in the organization, the project manager forwards the approved request for a product to that team. The central technical support team creates the Request for Proposal (RFP). If there is no central technical support team, the project manager creates the RFP. The project manager or the central technical support team should work with the technical architects to develop the proposal. If services, the project manager works the appropriate team leads to define the need and requirements for these services. For either product or services RFPs, the project manager ideally consults with the Contract Management Representative to leverage existing RFP templates and to include any client contract terms and conditions (“flow-downs”).

The RFP addresses all aspects of the supplier selection decision. These include product functionality, technical fit and performance, supplier characteristics, experience, and pricing. When appropriate, consider submitting a Request for Information (RFI), which is another way to collect information about the products and suppliers. RFIs are basically a list of questions that you would like a supplier to answer and usually precede an RFP.

More specifically, the RFP includes the following details:

- Details of the product/service requested
- Timelines for delivery
- Request for pricing details
- Date of submission of responses to the proposal
- Timelines of supplier evaluation and selection process
- A brief overview of the organization and the project

5.3.6 Monitor Suppliers

Monitor supplier activities, particularly prior to and during to product/service acceptance process.

Complete the Supplier Status Report to keep management apprised of the supplier status and any issues requiring management attention as described in Select Seller (3.5.8) actvities in Table 5.3. Follow the project issue management process to identify and resolve supplier issue through closure.

Issue resolution may require a modification or change to the Subcontract. If so, the project manager should involve the Contract Management Representative to assist in documenting the change to the subcontract by executing a change order or amendment. If an issue is unable to be resolved and turns into a dispute, the project manager should involve the Contract Management representative to assist in resolving the dispute and involving other resources, as needed.

The project manager or central technical support team should keep all documents related to the procurement process and store them based on the project Records Management Plan.

The procurement records will consist of both electronic and paper copies of all required procurement deliverables such as RFPs, subcontracts, change orders, etc.

Based on the status of the Subcontract or Service Level Agreements, the project manager or central technical support team can maintain the list of suppliers which are preferred. For preferred suppliers, the supplier selection can be omitted for future orders.

At the end of a Subcontract, work with the project manager to ensure all closing steps documented in the subcontract have been fulfilled.

5.3.6.1 Evaluate Suppliers

Evaluate suppliers and select the one that best meets the project requirements and the supplier selection criteria.

Suppliers are classified as authorized (Strategic, Preferred, Approved, Mandatory), or non-authorized. Organization can apply a code to each supplier to indicate the type of business relationship organization has with that supplier. The Program Management Office (PMO) or the central technical support team typically maintains a list of authorized suppliers which can be contacted for any standard products/services.

For first time suppliers or suppliers with non-standard products/services, follow these steps for supplier selection:

- Collect the supplier information.
- Conduct evaluation.
    - Fill out the Selection Scorecard for each supplier.
    - For each supplier, compute the supplier rating.
    - The supplier with the highest score is the most probable candidate for selection.

The Procurement Process Guidelines introduces the work activities and associated information requirements for the procurement of goods and services. This is a mandatory process when using vendors and procuring goods and services.

Selecting suppliers is considered a formal decision process. To understand whether performing DAR is required for this task and how to perform the DAR process. Use either the Supplier Selection or the Decision Analysis and Resolution (DAR) Report to document the selection criteria and summarize the results.

5.3.6.2 Establish Subcontract

Once the supplier has been selected, a subcontract is prepared and negotiated with the selected supplier. This subcontract describes the terms of engagement, service levels, pricing, etc.

Identify and approach the appropriate Legal and Commercial contact to establish a Subcontract. Use the Subcontract to document supplier agreement and responsibilities.

The Legal & Commercial (L&C) Contract Management Representative is responsible for:

- Performing subcontract administration, including modifications, task orders and subcontracts
- Working with the project manager and supplier to determine, communicate, and address possible changes to the subcontract
- Monitoring subcontract compliance
- Providing a contract administration document library
- Providing support for subcontract plans
- Providing project management support, including contract deliverables tracking, risk/issues tracking and invoice/payment tracking
- Providing subcontract awareness training
- Providing contract management best practices

The following principles apply to the subcontracting efforts:

- Clearly define the scope and timescales for the provision of goods or services.
- Make sure that the terms of the subcontract are consistent with the provisions in the prime contract with the client, including applicable flow-down clauses.
- Clearly state any consideration of the terms contained in other related agreements such as Teaming Agreements.
- Clearly define the value of the contract and payment terms and conditions.
- Define the change process.
- Define the deliverables.
- Clearly state the acceptance criteria for supplier deliverables.

A purchase order is required in order to pay the supplier for the supply of a particular product or service. The purchase order will have the details of product, quantity ordered, rate, shipment address, terms of payment, date of delivery, etc.

5.3.6.3 Perform Product Acceptance

Follow the Procurement Plan and Project Plan when completing product acceptance.

Monitor supplier status and manage to confirm that product/service is delivered based on the terms specified in the Subcontract and the Service Level Agreement.

Confirm that the facilities and infrastructure are in place to accept the product or service. Once the project manager or central technical support team receive the product or service they have to verify it against the initial requirements to ensure that it conforms. Develop a Test Plan to help confirm the requirements are being met. Document the outcome of this test in the Test Closure Memo and send a copy to project manager.

Once the product or service has been verified and accepted, follow the appropriate process to ensure that the financial obligations set in the subcontract are fulfilled. As appropriate, confirm that supplier support and maintenance responsibilities are executed in accordance with the Service Level Agreement and Subcontract.

If a product acquired has to be installed in the project location as per the project requirements. The project manager or the technical support team is responsible for this activity.

If service, confirm that the services provided follow the terms specified in the Subcontract or Service Level Agreement.

5.3.7 CM Planning

- Identify configuration items (CIs) to be managed under the Configuration Management processes as per the activities for Continuous Improvement (3.5.2) in Table 5.3
- Appoint members to the change control board.
- Create, manage, maintain, and communicate the Configuration Management Plan and any CM standards and procedures to all stakeholders.
- Ensure all project team members involved in CM receive training on their roles, how to perform their activities, and how use CM tools.
- Update the Configuration Management Plan, as appropriate, and only after change control board approval.
- Communicate any updates to the Configuration Management Plan to the appropriate project team members.
- Establish a project schedule for CM activities with the project manager
- Form and manage a CM team, as needed.
- Conduct performance review for members of the CM team, as needed.

5.3.7.1 Implement Changes

- Create products from the CM library as authorized by the change control board.
- Process and track change the requests and subsequent updates to the CM library.
- Coordinate configuration item change requests (CICRs) reviews with the change control board.

5.3.7.2 Track and Report on CM Status/Audits

- Maintain the integrity of all CIs by monitoring the status of all CIs and tracking problem reports associated with them.
- Conduct audits of CM activities as planned, including performing a baseline audit prior to closing baselines.
- Track, report, and communicate CM status and audit reports to the project manager and client director.

- Initiate, record, review, approve, and track all CICRs and problem reports for all configuration items according to the procedure documented in the Configuration Management Plan.

5.3.7.3 Maintain Library

- Create and manage, including the security, the CM library tool(s).
- Provide project team members appropriate access to the CM library.

5.3.7.4 CM Deliverable Owner

The CM deliverable owner has the following responsibilities:

- Designate an individual as responsible for any of the tasks mentioned under the configuration manager.
- Name the designated CM deliverable(s) (e.g., maintain library, implement changes, report status, etc.) and the owner of the deliverable in the Configuration Management Plan.

5.3.7.5 Plan Stakeholders

List the project's stakeholders in the Configuration Management Plan. This will include information such as the following:

- Organization
- Role stakeholder name
- E-mail
- Phone number

Reference the Project Communications Plan for additional information about the client organization, project stakeholders, and the communication methods to use if the Configuration Management Plan changes.

5.3.7.6 Plan and/or Process Dependencies

Some plan and/or process dependencies may exist. Examples include the Project Plan, Project Measurement Plan, and project Work Plan.

Evaluate these to determine if updates are necessary, assuming alterations are made to the Configuration Management Plan.

5.3.7.7 Determine Categories of Configuration Items

A CI is defined as a deliverable that requires configuration control. A CI may be a single piece of work or a group of files that together form the basis for a single program or document.

Figure 5.8 Configuration Items

Configuration identification is the process for selecting, identifying, and naming CIs.
Some examples of CI categories include the following:

- Project documentation (e.g., Project Plan, Configuration Management Plan, design documentation, etc.)
- Architectures
- Interfaces
- Process descriptions
- Project data, Requirements and Designs
- Source code and executable code
- Test scripts and Test data
- Commercial Off the Shelf (COTS) software (e.g. S/w management tools, CASE tools, etc.)
- Public domain software (e.g., compilers, editors, etc.)
- Data dictionaries
- Training materials
- Databases that include processed data and data that are part of the system
- Metrics, status reports, quality review reports, etc.
- Decision analysis and resolution artifacts

Similar configuration items are grouped in the same category. See the Configuration Items section for further examples of categories used in CM.

5.3.7.8 Determine Levels of CM Control

The project determines and defines the levels of CM control that each CI category needs. For example, the project may choose to place fairly static CIs (e.g., meeting minutes or status reports) on the Local Area Network as read-only files maintained by the individual leads. These CIs would be maintained at the lowest level based on the project's Configuration Management Plan.

However, the project would include all dynamic CIs (e.g., source code and embedded systems) in the project's CM library (e.g., PVCS, BI Designer, Documentum, VSS, etc.).

5.3.7.9 Determine Configuration Item Naming Conventions

The project utilizes and identifies the standard naming conventions for all CIs as part of the CM process. Document this in the Configuration Management Plan. Use separate naming conventions to distinguish between configuration items (e.g., CI category: software/hardware, documents, etc.) that will be delivered to the client (e.g., deliverables) and those configuration items used internally by the project team (e.g., non-deliverables).

For instance, an application architecture in the Design category may have the following naming standards:
<filename> <date/time stamp> <y.z> <filesize> <checksum>
Example: script.c 04/03/2001 01:45am 3.2 1.34mb 437x777

5.3.7.10 Configuration Items

Some CIs will be identified to be placed under CM. The CIs identified are grouped in various baselines based on project needs (e.g., requirements baselines, design baselines, production baselines). Account for and track all changes that occur to the baselines during the project.

For example, a CI list could include the following information:

- CI category
- Description
- Baseline name
- Date or stage CI placed under CM
- Owner
- Repository/Path (location of CI)
- Level of CM control
- CI name/reference document

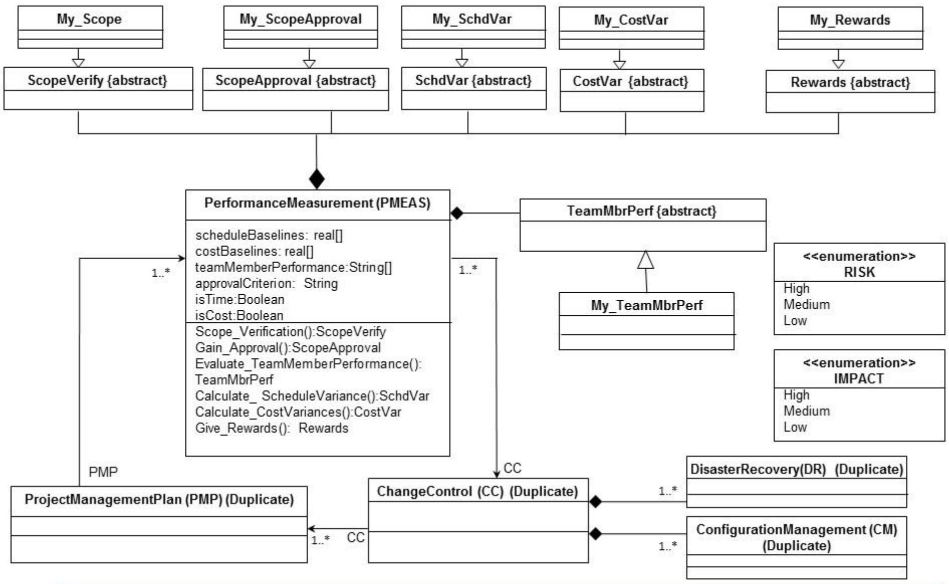
5.4 Project Monitoring and Controlling Process Group

This consists of various processes performed to monitor and control project execution as per performance measurement parameters and take appropriate preventive and corrective action in a timely manner. Project Monitoring and Control provides insight into the project's progress so corrective actions can be implemented when the project does not progress according to plan.

The team should manage the project as per the requirements and measure the performance of project and resources to the baselines defined in the project plan and monitors various variances. Scope is also verified and approval gained from the appropriate stakeholders for various activities of the project.

Team takes care of various risks and their impacts on the project. Depending on the risk team takes appropriate preventive or corrective action. Risk is categorised into High, Low, Medium and its impact is also evaluated for high, medium, or low. Considering the Risk matrix, an appropriate action is taken.

Regularly compare the actual work products, tasks, effort, cost, and schedule to the project plan to measure the project's progress. Use metrics to provide objective data regarding status. Visibility into the project status enables the corrective action implementation when performance deviates significantly from the plan. Monitor the risks, commitment, stakeholder involvement, and milestones. The effort includes analysing deviations, taking corrective actions, and managing and monitoring corrective actions to closure.



context PMP::ManageRisk()
pre: (RISK=HIGH and IMPACT=HIGH) or (RISK=MEDIUM and IMPACT=HIGH) or (RISK=LOW and IMPACT=HIGH)
post: ^cc.Do_CorrectiveAction()

context PMP::ManageRisk()
pre: (RISK=HIGH and IMPACT=MEDIUM) or (RISK=MEDIUM and IMPACT=MEDIUM) or (RISK=LOW and IMPACT=MEDIUM)
post: ^cc.Do_PreventiveAction()

Figure 5.9 Project Monitoring and Controlling Process Group

Project is monitored and controlled as per the defined measurement matrices. Variances are to be calculated for cost and time and preventive and corrective actions taken. The main objectives of Project Monitoring and Controlling are:

- Manage the work using the work plan defined in the Project Plan.
- Measure progress and performance against the plan.
- Identify and manage issues and risks.
- Resolve issues and remove barriers by determining and taking appropriate corrective actions. Manage the involvement of stakeholders in project tasks.
- Perform re-planning and re-estimating at key milestones or scope changes.
- Revise original plan and establish new agreement as needed.

Performance is measured as defined in the *PerformanceMeasurement(PMEAS)* class. Performance is measured based on the attributes of scheduleBaselines: for time; costBaselines: for budget; teamMemberPerformance: for giving rewards, approvalCriterion: for completion of task. The team performs the operations of ScopeVerification(): for verifying the task done against the approved scope of the project; Gain_Approval(): to get the approval once the task has been done as per the scope; Evaluate_TeamMemberPerformance(): to assess the team member performance against the agreed objectives; Calculate_ScheduleVariances(): against the duration approved; Calculate_CostVariances(): against the approved budget ; and Give_Rewards(): to give rewards to the members meeting the objectives.

The process may have to be repeated a few times so that project is completed successfully within the scope, time, cost, and quality delivered as per the agreed statement of work and parameters of acceptance.

Table 5.4 Project Monitoring and Controlling Process Group mapping

PMBOK[1] processes and activities (section)	**Formalised Model**
Verify Scope (3.6.3) Scope Control (3.6.4)	Scope_Verification() operation
Schedule Control (3.6.5)	ManageSchedule() operation
Cost Control (3.6.6)	ManageBudget() operation
Perform Quality Control (3.6.7)	ManageQuality() operation
Manage Project Team (3.6.71, 3,6.8)	TeamMemberPerformance() operation
Measure Team Performance (3.6.1, 3.6.8), Report on Performance (3.6.1)	Evaluate_TeamMemberPerformance() operation
Manage Stakeholders (3.6.9)	Gain_Approval() operation
Risk Monitoring and Control (3.6.1, 3.6.2, 3.6.3)	ManageRisk() operation Risk conditions

PMBOK[1] processes and activities (section)	**Formalised Model**
Integrated Change Control (3.6.1, 3.6.2, 3.6.3)	ChangeControl class (Duplicate)
Configuration Management (3.6.1, 3.6.2, 3.6.3)	ConfigurationManagement class (Duplicate)
Approve Changes, Disaster Recovery Preventive and Corrective Actions (3.6.1, 3.6.2, 3.6.3)	ChangeControl class (Duplicate) Operations: Do_PreventiveAction() Do_CorrectiveAction() Do_DisasterRecovery()
Determine Variances (3.6.1, 3.6.2, 3.6.3)	Operations: Calculate_ScheduleVariances() Calculate_CostVariances()

The guidelines and considerations on how to perform project planning and tracking.

5.4.1 Confirm Project Scope

This step confirms and further clarifies the project scope and ensures that the project team fully understands it before detailed project planning begins. The project scope is primarily documented in the following documents:

- Project Statement of Work
- Requirements from the Define High-level Requirements
- Solution Blueprint from the Define Solution Blueprint
- Project Description located in the Project Plan
- Project Scope Definition

As defined by Verify Scope (3.6.3) and Scope Control (3.6.4) activities in Table 5.4, confirm in-scope Requirements by completing the following:

- Review the major user scenarios, major business processes, and prioritized high-level requirements created during Define High-level Requirements.
- Review the Solution Blueprint created during Define Solution Blueprint.

Additionally, ensure the appropriate stakeholders agree on out-of-scope requirements. Requirements that are deemed out-of-scope can affect requirements that are still in-scope. Thoroughly analyze these dependencies, and adjust decisions accordingly.

Document the project scope within the Project Scope Definition, as appropriate for the project. For example, scope can be documented in terms of business units, geographic areas, business processes, technology, people factors, and what is out-of-scope.

Review the project scope with the appropriate stakeholders to confirm understanding and agreement.

Based on changes to in-scope and out-of-scope items, update the delivery strategy documents as needed. Review the updated Delivery Strategy with the appropriate stakeholders to ensure a shared understanding of the changes.

5.4.2 Develop a Work Plan and Budget

A Work Plan describes the key deliverables produced, the activities performed, the estimated effort required, and key completion dates at the task level as described by activites Schedule Control (3.6.5) and Cost Control (3.6.6) in the table 5.4. The task level is generally a sufficient level of detail both for estimating and for managing work, and it is the level where the current and the upcoming work stages are usually estimated.

The estimated amount of work for each task is based on the bottom-up estimate from company-approved estimating tools or documented historical estimates and assumptions from similar projects. The task-level defines specific tasks to perform to produce the project's deliverables. It is the basis for the project's approach and staffing requirements. Typically, work planning is driven based on the project's requirements and/or the Project Statement of Work.

When adding tasks to the Work Plan, consider critical dependencies that might exist between related tasks. For example, tasks related to application design may depend on requirements definition tasks first being completed. When such dependencies are identified, ensure they are represented in the Work Plan.

Some work planning software, such as Microsoft Project, allows linking tasks. The software then automatically adjusts the properties of a linked task (e.g., Planned Start Date and Planned End Date) based on the progress of its dependencies. If the project's work planning software does not contain linking capabilities, monitor and update inter-dependent tasks manually.

The Work Plan (at a minimum) must have the following elements:

- Task/Milestone. Describe the task or activity to complete.
- Resources. Assigned responsibility to the resources or team members completing task
- Planned Start and Finish Date
- Actual Start and Finish Date
- Baseline Work. List the number of hours (work) originally planned to complete the task or milestone.

- Work to Date. List the actual cumulative hours (work) spent on the task
- Estimate to Complete (ETC). List the number of hours the team members estimate as needed to complete the task or milestone.

Baseline Work is the number of hours estimated to complete a task or milestone. The baseline is set during the planning of the detailed tasks included in the Work Plan. Once set, only modify it when a Change Request or Contract change is approved.

Work to Date is the cumulative number of hours spent on a task or milestone. Pull the hours directly from either the team members turnaround documents or other time reporting mechanism. Do not use an estimate based on the percent complete.

The Initial Estimate is initially developed during the Opportunity stage and then refined to consider external factors and contingency, experience, labor rates, and non-labor related expenses.

Since estimating can be performed in different ways, consider the following criteria to choose an estimator for project use:

- Method of estimating. Consider high-level feasibility analysis, top-down estimating, and bottom-up estimating.
- Estimating results. Consider effort-based, resource-based, financial/cost, schedule, time, etc.
- Scope of work. Consider managing, planning, delivering, operating, etc.
- Type of work. Consider business integration, eCommerce, custom application development, packaged software implementation, client/server, NetCentric development, etc.

5.4.2.1 Track Project Schedule/Time Process

Schedule and time monitoring track the project's progress toward its deadlines and ensures the project meets its deadline and budget expectations.

Figure 5.10 identifies the process for monitoring schedule and time on a project.

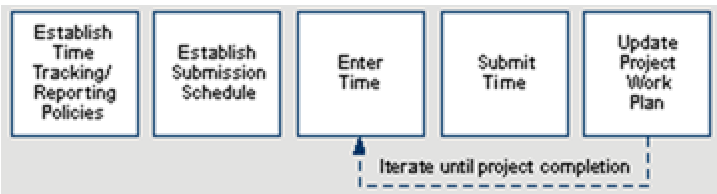


Figure 5.10 Track Project Schedule

5.4.2.2 Establish Time Tracking/Reporting Policies

Project management establishes time tracking/reporting policies for the project. The established policies must be consistent with organizational and/or contract-related policies and procedures. The policies and procedures include information on how the project tracks time at the task or milestone level. In addition, if the project utilizes subcontractors, the project addresses how subcontractors track/report time they spend on project activities. Project time tracking/reporting policies are typically located with the project's documented administrative standards, policies, and procedures.

5.4.2.3 Establish Submission Schedule

Project management establishes a schedule for the time spent on activities in the Work Plan. Project management may choose to establish a schedule that is consistent with the organizational time submission procedures. The submission schedule reflects the frequency which project the management team needs access to time spent on tasks in the Work Plan (e.g., on the 15th and end of month; bi-weekly, etc.).

5.4.2.4 Enter Time

For a given time period, the individual team member/subcontractor enters the time spent on tasks in the Work Plan in the project's turnaround document and/or other project time tracking tool according to the established schedule and policy. The turnaround document can be presented in various formats (e.g., Microsoft Word, Microsoft Excel, Microsoft Access) and must list the exact tasks listed in the Work Plan.

The project must specify where the time tracking tool is located. See the Organize Project Documentation section of this document for more information. The individual team member reviews the time entered before submitting it to the repository.

5.4.2.5 Submit Time

For a given time period, the individual team member/subcontractor submits the completed turnaround document and/or other project time tracking tool to the defined repository according to the established schedule and policy. See the Organize Project Documentation section of this document for more information.

5.4.2.6 Update Project Work Plan

The Work Plan is updated based on time submissions received from team members/ subcontractors.

Project planning also includes the following activities:

- Configuration management planning and execution of configuration management activities, including audits
- Communication and sponsorship planning and execution of communication and sponsorship activities, such as status meetings, status reporting, project training delivery, etc.
- Measurement activities, including collection, analysis, and reporting

There are additional project management plans to include in the Project Plan. If a project finds it more effective, they may group all project management items into a single Project Plan.

Alternatively, they may choose to list them separately. Possible items for inclusion in the Project Plan include, but are not limited to, the following:

- Quality review planning and execution of quality review activities, including execution of peer reviews, process and product quality assurance (PPQA) reviews, best practices reviews, and quality assurance (QA) reviews
- Risk management planning and execution of risk management activities
- Administrative items, such as status reporting, time tracking, QPI support, etc.

5.4.2.7 Project Tools

During project start-up, select the tools the project uses. Tools may be selected to manage the following project areas:

- Issue management
- System Investigation Request (SIR)/Change Request (CR) management
- Risk management
- Schedule management
- Effort and cost management
- Configuration management
- Requirements management
- Quality management

If a Program Management Office (PMO) exists, the project typically uses the same tools as the PMO. However, if a PMO does not exist, the project chooses tools to manage the areas listed above.

If a project needs to choose its own project management tools, follow the decision analysis and resolution (DAR) process. The project's DAR process is outlined in the Project Plan and Decision Analysis and Resolution Guidelines.

5.4.2.8 Organize Project Documentation

At the project's onset, the project manager and/or project team leads define a project-standard file and folder structure for the project network and/or any content management tools used by the project. Content management tools aid projects in the configuration management life cycle by storing, tracking, and managing project and system deliverables.

By defining a standard, confusion about where to store documents is eliminated, and documents can be located more quickly and easily. Document the project's file and folder structure in the Project Orientation and Training Materials.

A recommended folder structure for the project's network and/or content management tool is outlined below:

- Administration
  - Policies
  - Orientation materials (e.g., orientation binder, roll-on forms, etc.)

- Meetings
    - Team (agenda, meeting minutes)
- Status Reporting
    - Team (MM/DD/YYYY)
    - Client (MM/DD/YYYY)
- Time Reporting
    - Artes (MM/DD/YYYY)
    - Turnaround documents (MM/DD/YYYY)
- Plans (include all documented project and related plans, e.g., Project Plan)
- Standards (include all project standards, e.g., design, code)
- Tools
    - Issue (user documentation)
    - Risk (user documentation)
    - SIR and CR (user documentation)
- Requirements
    - Release 1
    - Release 2
    - Release XX
- Design
- Build
    - Code
    - SQL

Customize these folder structures to meet project needs. When designing a project folder structure, project management considers security needs for the various folders. For example, folders that contain project financial information may need to be placed in a secure folder.

Not all content management tools are created for the same purpose. For example, Visual SourceSafe is used primarily as a repository for system development deliverables (e.g., code).

5.4.3 Assign Project Organization

Project organisation is assigned and their performance measured against the baselines as per the Manage Project Team (3.6.71, 3,6.8) and Measure Team Performance (3.6.1, 3.6.8), Report on Performance (3.6.1) activities given in the Table 5.4

5.4.3.1 Project Continuity

An organisation strives to provide continuity of key personnel across all stages of a project's life cycle. This helps ensure scope containment between the original requirements outlined, discussed, and documented during the proposal process are adhered to in development and delivered. To facilitate this continuity, identify individuals who are currently project team members who were members of the project proposal team and/or have been on the project for a sustained period of time.

5.4.3.2 Project Organizational Chart

The project organizational chart provides a hierarchical depiction of the project team's structure. The organizational chart is prepared during the planning stage. The organizational chart diagram is embedded in the Project Plan. The chart is a living document that is updated as organizational changes occur and as the project progresses through stages.

5.4.3.3 Assign Project Roles and Responsibilities

Roles and responsibilities for any project detail the types of roles that make up the project team and the project team member's responsibility in that role. It is provided to prompt project consideration of roles and/or responsibilities that could play a part in project work. These roles and responsibilities can be deleted, added, or redefined as applicable for the project.

5.4.3.4 Measure Project Performance Process

Measure Project Performance Process determines project performance measures, captures actual performance data, and calculates performance measures. This provides visible measures of progress and status for the project. The data captured in performance measurement is a key input for Manage Project Performance.

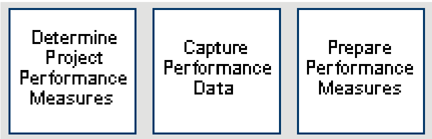


Figure 5.11 Process used to measure project performance.

5.4.3.5 Determine Project Performance Measures

Project performance measures track project progress and measure the effectiveness of project processes. The Project Measurement Plan defines measures the project captures; however, the project defines additional specific measures to track and monitor its performance. Additional areas to consider when defining project-specific metrics are testing, configuration management, profitability, and scope control.

Some examples of performance measures that may be captured include:

- Actual effort (i.e., hours) and other resource usage when applicable
- Task percent complete/expended
- Estimates to complete (ETC)
- Number of open issues (See the project's Project Plan and Issue Management Plan for more information.)
- Number of open/realized risks (See the project's Risk Management Plan for more information.)
- Actual project costs (e.g., project expenses, resource costs (actual effort x resource cost), etc.)
- Process effectiveness (e.g., peer review problem density, stage containment, defect density, etc.)
- Product quality (e.g., peer review problem category density, SIR type percentage, fault density, etc.)

5.4.3.6 Capture Performance Data

Turnaround documents (T-DOCs), team Status Reports, and actual project expense data are key inputs into the Gather Team Status and Metrics Data step within Monitor and Control Project. Review these documents to obtain a complete picture of the actual effort and costs expended on project tasks by the project team members.

Capture the data necessary to calculate both organizational and project–specific performance measures (e.g., metrics). The Status Report and turnaround documents capture most of this information. However, additional sources of information may be needed to capture the appropriate performance data (e.g., actual project costs).

Review and verify all captured data for accuracy and completeness. Track the reviewed and verified data using the project's chosen schedule/cost and effort management tool. For more information on project tools.

Performance measures are typically gathered on a monthly basis. However, depending on the project's size and schedule, performance measures may be captured more or less often. For more information on metrics tracking tools.

Outputs of this process are performance measures necessary for the calculation of the project-specific measures as indicated in the Project Measurement Plan.

5.4.3.7 Prepare Performance Measures

The process owner calculates and documents the project-specific measures defined in the Project Measurement Plan using the captured performance data. In most cases, the process owner for project management activities will be the project manager or team leads. Track the calculated performance measures in a project-defined location.

Performance measures are typically calculated on a monthly basis. However, depending on the project's size and schedule, performance measures may be captured more or less often. Report any project-specific measures in the Status Report.

The projects must quantitatively manage the processes and sub-processes outlined in the Project Measurement Plan. Quantitatively managing processes and sub-processes refers to capturing and tracking event-level process data to monitor "the performance of the selected sub-processes to determine whether they are capable of satisfying their quality and process-performance objectives, and identifying corrective action.

5.4.3.8 Manage Project Performance Process

Project performance is managed against the baselined work plan and budget for effort, schedule, quality, risk, and cost. Performance management is performed to assess project performance, identify issues, evaluate and select corrective actions, and initiate the selected actions.

The outcome of this task is the project being managed to a plan, corrective actions being taken, project performance being assessed, performance issues being identified, and project changes being identified and requested.

Figure 5.12 shows the process used to manage project performance.

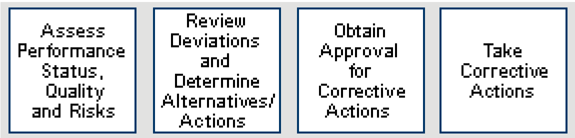


Figure 5.12 Manage Project Performance

5.4.3.9 Assess Performance Status, Quality and Risks

Project management must use the calculated performance measures documented in the Measure Project Performance Process to examine the progress team members make toward the completion of their work and assess how efficiently and effectively the work effort meets the project objectives.

Project management must continuously assess project quality, risks, and the project's overall status.

Key activities of this step include the following:

- Meet with project team members (e.g., weekly status meetings). Review the results of the resources applied to work package activities to assess progress with respect to time expended and meeting schedule dates.
- Verify that items outside project scope are not being worked on.
- Evaluate work effort vs. plan.
- Evaluate actual resource availability vs. plan.
- Determine performance trends by analyzing performance measures.
- Determine root causes of variances as a basis for developing action plans.
- Determine the significance and impact of variances.
- Assess the project risks and efficiency of risk management strategies.
- Verify or revise estimates to complete and estimates at completion.
- Identify issues requiring resolution, including quality review issues and recommendations.
- Be proactive in taking immediate corrective action where appropriate.

5.4.4 Obtain Stakeholder Agreement

Review the planning documents with the project team leads, and confirm their agreement prior to reviewing the documents with project sponsors and other key stakeholders corresponding to the activities of Manage Stakeholders (3.6.9) given in the Table 5.4

Typically, project deliverables are formally signed off at the completion of a stage of work (e.g., during Confirm Planning Deliverables). However, the importance and impact of the Project Plan, related management plans, and key planning documents (e.g., Work Plan) are such that they must be reviewed and signed-off by project stakeholders when they become relatively stable but before they are used as an input to subsequent activities.

Use this step to review the Project Plan, related management plans, and other key planning documents (e.g., Work Plan) with all relevant stakeholders, obtain sign-off, and place them under configuration management.

5.4.5 Review Deviations and Determine Alternatives/Actions

For all significant deviations requiring resolution based on the assessment of overall performance, status, quality, risk and cost, project management may complete the following:

- Conduct problem-solving meetings (when appropriate) to assist in identifying and selecting possible corrective actions.
- Evaluate possible corrective actions to determine the appropriate action to take.
- Document issues and their resolutions. For more information, see the Issue Management Plan or the SIR/CR Management Process. If the project references these processes in the Project Plan, see the Project Plan.
- Document newly identified risks. For more information, see the Risk Management Plan and the Risk Management Guidelines. If the project references this process in the Project Plan, see the Project Plan.

The project manager and/or team leads initiate any corrective actions they are empowered to take.

The output of this step is an updated issue, risk, SIR, or CR in the appropriate tracking tool. Obtain Approval for Corrective Action as per the activities Risk Monitoring and Control (3.6.1, 3.6.2, 3.6.3) and Integrated Change Control (3.6.1, 3.6.2, 3.6.3) given in the Table 5.4.

In connection with controlling the project work, the project manager has already initiated the corrective actions he or she is empowered to take. However, the approval and/or buy-in of key stakeholders is required for corrective actions involving significant impact or resolving differences of opinion on the course of action to be taken. Some examples of these kinds of corrective actions can be characterized as follows:

- Actions that require management approval, including major changes affecting project scope, effort, or schedule baselines

- Actions that do not require management approval but require re-planning before implementation

These second types of actions are documented as project re-planning changes prior to modifying the detailed Work Plan. While these actions can be taken directly by project management, obtain appropriate stakeholder consensus and buy-in for actions that are contentious, have significant impact, and/or affect stakeholders outside the project team.
Formal approval of such corrective actions is normally obtained in status review meetings. However, these items are almost always discussed individually with the relevant stakeholders before issuing status/performance reports and conducting status review meetings.

Take Corrective Action

There are three types of corrective actions to take:

- Actions that the project manager is empowered to implement immediately to correct a problem that does not require re-planning
- Actions that do not require management approval but require re-planning before implementation
- Actions that require the approval of management and are typically major changes that affect the project scope, effort, or schedule baselines

Corrective actions may include the following:

- Work process changes
- Team building
- Staff training
- Increased or decreased supervision
- Resource work assignment changes
- Reassignment of team members
- Implementation of quality action teams
- Initiation of risk responses, as necessary
- Change requests to be addressed within the configuration management process
- Project re-planning changes that specify needed modifications to the Work Plan (Use the documented project assumptions to help revise the Work Plan.)
- Project Plan revisions (Work Package changes, etc.)
- Escalation to management.

The project manager takes appropriate action to make all changes necessary to resolve problems. For all other corrective actions, the project manager consults with senior management.

5.4.6 Communicate Project Status Process

The project's status reporting process is used to monitor the progress, identify issues, and effectively manage resources. Perform this on a recurring basis to communicate project status and performance information to all project stakeholders.

Review the project status at three levels: the project team to manager, the manager to senior management, and the manager to the team. A well-implemented status reporting process facilitates internal and external communication for the project team. A project's status reporting process reflects how status reporting is conducted in the project's environment. Once defined, distribute it to and have all project team members follow it.

The Status Reporting process is supported by Status Reporting templates. Depending on project needs, the project requires templates for individual, team, project, and configuration management Status Reports. The project may need to create additional status reporting templates as necessary.

Figure 5.13 shows the process used to communicate project status.

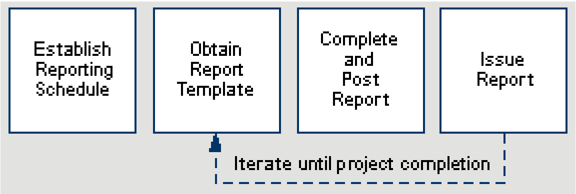


Figure 5.13 Communicate Project Status

5.4.6.1 Establish Status Reporting Schedule

Typically, status reporting is performed on a weekly basis. Friday is the most popular due date for Status Reports. However, reports to senior management may occur on a monthly or quarterly basis. In addition to Status Reports, status communication can also be performed in status meetings. Plan for status meetings at both the project and management levels. If Status Report templates need to be created (e.g., team, individual, etc.), create those templates during this task.

5.4.6.2 Obtain Report Template

Typically, each individual team member is responsible for obtaining the appropriate Status Report template from the local area network (LAN) or other specified location. Specify the template location as part of the project's Status Communication Process.

Usually, all project team members, with the exclusion of the project manager, obtain the individual Status Report template; only the team lead accesses the team Status Report template; only the project manager accesses the project Status Report template; and only the configuration manager accesses the configuration management Status Report template.
However, there are some exceptions. Instead of using the individual Status Report template, individual team members may put their status in the team Status Report template for team lead review. If using the individual Status Report template, the team lead consolidates the team member status from the individual Status Report template into the team Status Report template.

5.4.6.3 Complete and Post Report

The individual team member completes the requested fields of the appropriate Status Report template. Individual team members review their own status and performance prior to completing the report. For the team Status Report, the team lead reviews all individual Status Reports. For the project Status Report, the project manager reviews the team Status Reports and other project status and performance measures to complete the report. Complete all reports, and post them in accordance with the established status reporting schedule.

Upon completion of the Status Report, post it is a project-specified location, most likely the project's local area network (LAN). Several paths may exist due to the various types of Status Reports. Document the path(s) for posting the Status Report as part of the project's Status Communication Process.

5.4.6.4 Issue Report

The project manager sends project Status Reports and other reports to the appropriate project personnel/stakeholders, as identified in the status reporting schedule and/or Project Communications Plan.

Status review meetings may be conducted for various organizational levels. Involve the project manager at two levels: status review meetings at the management level and status review meetings within the project team. Both of these review meetings are required on a regular basis.

The project manager may need to meet with senior management to discuss the high-level project status. Project information discussed with management and other management-level stakeholders is usually less detailed, higher level, and exception based.

5.5 Project Closing Process Group

The closing processes include various activities to close and finish the project. The team hands off the completed project or product to the appropriate stakeholders or close a cancelled project.

The project is completed as per the acceptance criterion defined in the project management plan. The final reports are generated and lesson learned log is created. The project resources are released. The main objectives of the project closing are given below:

- Close out the completed project, and evaluate its overall results.
- Ensure all project activities have been completed.
- Finalize all documentation, and transfer responsibility to the new responsible parties.
- Release all resources.
- Perform process improvement activities: conduct project review meetings, document lessons learned, harvest knowledge assets and submit the assets to organization-wide repositories for reuse.

Project is to be closed once the acceptance criteria are met and the project is delivering the required performance. Stakeholders give their approval for the closure of the project. A final report is written and lesson learned log is created for the future projects to learn from the current project and will serve as reference. The resources are released so that they are available to work on new projects.

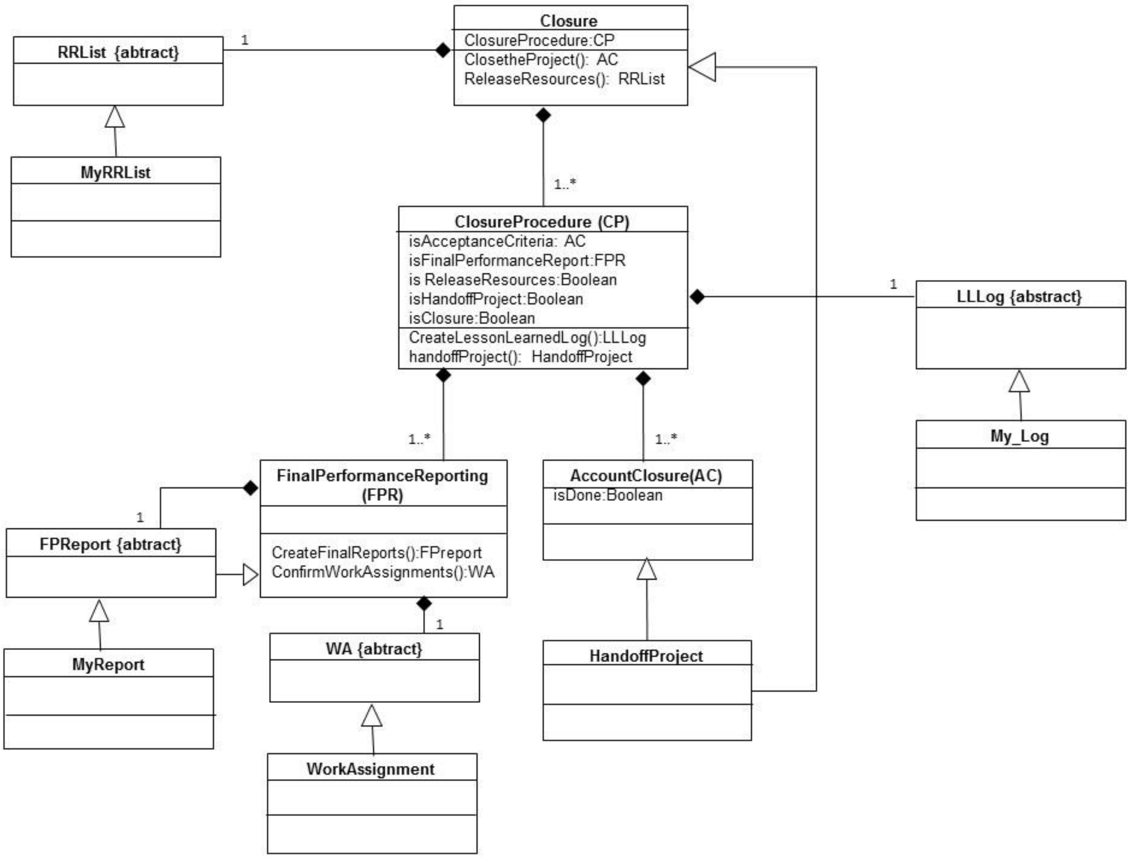


Figure 5.14 Project Closing Process Group

Closure class has an association with *ClosureProcedure(CP)* class through the Closure Procedure. The Project is closed by performing the tasks in ClosetheProject() operation and then releasing the resources as defined in the ReleaseResources() operation.

The *ClosureProcedure(CP)* class has the attributes of isAcceptanceCriteria: which is used to evaluate the project against approved criterion for completion. The criterion could be based on the project deliverables, change and transformation processes implemented, application, or system delivered. Stakeholders approve the project once the task has been completed as per the laid down criteria of Cost, time, scope, quality, etc.

The attribute isFinalPerformanceReport is associated with *FinalPerformanceReporting(FPR)* class which is used to perform two operations of generating final reports using CreateFinalReports() and confirming that the work has been completed as per the expectations and approved criterion using the method ConfirmWorkAssignments().
When the project has been completed and handed over to the client and the client signs off the project, the resources are released and the project is closed.

Use the Lesson Learned Log to identify the deliverables to be harvested, cleansed (as needed), and posted to the knowledge management repository. Project evaluation data (actuals vs. estimates) is documented in the project estimating group for integration into the estimating model.

The project manager should do the followings:

- Identify the key artefacts that can be shared. This could include the estimation model, project plans, development strategy, Risk Log, Best Practices, metrics etc.
- Review these artefacts for suitability.
- If the organization has a Process Improvement team or a Software Engineering Process Group (SEPG) or knowledge management team, submit the artefacts to this group.

5.5.1 PMBOK and formalised model mapping

Table 5.5 Project Closing Process Group mapping

PMBOK[1] processes and activities (section)	**Formalised Model**
Administrative Closure Procedure (3.7.1)	Closure class ClosureProcedure class ClosetheProject() operation
Hand off completed product, service, or result (3.7.1, 3.7.2)	HandoffProject() operation
Confirm work is done to requirements (3.7.1)	ConfirmWorkAssignments() operation
Contract Closure procedure (3.7.2)	AccountClosure (AC) class

PMBOK[1] processes and activities (section)	**Formalised Model**
Release Resources (3.7.1)	ReleaseResources() operation
Final Performance Reporting (3.7.1)	CreateFinalReports() operation
Update Knowledge Management database (3.7.1)	CreateLessonLearnedLog() operation

5.5.2 ClosureProcedure

This list helps close out project operation and transition the appropriate management details to the client or application management team as described by the activities Administrative Closure Procedure (3.7.1) and Hand off completed product, service, or result (3.7.1, 3.7.2) in the Table 5.5.

5.5.2.1 Prepare for Project Closure

- Understand policies for closing project.
- Prepare a back-up and archival plan.
- Prepare for packaging project knowledge assets and experiences to be contributed to the Knowledge Exchange, capability group, methodology group, etc.
- Confirm deliverable ownership and a deliverable transition plan.
- Approach the appropriate organization contact to complete the closing activity such as legal and commercial, finance, human resources, etc.
- Prepare a closure presentation for the client’s management team.
- Confirm the plan and schedule for project closure activities.

5.5.2.2 Confirm the Sign-off Checklist

- Ensure all sponsors and stakeholders agree to the sign-off checklist.
- Confirm the metrics that the project must achieve before transfer is accounted for.
- Confirm the transition of all reporting, planning, and metrics tracking.
- Document and obtain approval from the client on what formal acceptance of the application means.

5.5.2.3 Confirm the Document Retention Policy

- Confirm adherence to the current company retention policy as per the activities Confirm work is done to requirements (3.7.1) given in the Table 5.5.
- Leverage the records lead at the program level.
- Clear any retention policy changes with the company’s legal department.
- Validate that the client agreed with the retention policy.
- Confirm adherence to the company’s vaulting/archiving approach.

5.5.3 Confirm Rights and Obligations

- Identify any type of warranty support required after transitioning the application.

- Confirm agreement to IP rights.
- Confirm your third party release approach to minimize penalties.
- Confirm the terminations of rental or lease agreements.

5.5.3.1 Confirm Transition of Deliverables

- Confirm deliverable ownerships.
- Obtain agreement on all transitioned deliverables.
- Walk through the transitioned deliverables and turnover ownership.

Contract Closure procedure (3.7.2)	AccountClosure (AC) class

5.5.4 Confirm the Contact Plan

- Determine and document who the client contacts with questions after transitioning the application corresponding to the activities Contract Closure procedure (3.7.2) defined in the Table 5.5.
- Determine and document who is responsible for periodic relationships and meetings to continue client relationships.

5.5.4.1 Confirm Archival and Record Retention

- Retain or dispose of archives and records in compliance with contractual obligations and applicable legal and regulatory requirements, such as tax or data privacy laws, which may vary by jurisdiction.

5.5.5 Release Resources

- Communicate roll-off dates at least two weeks prior to the actual roll-offs as defined in the activities Release Resources (3.7.1) in Table 5.5.
- Update the Roll-on/Roll-off Form with the roll-off information.
- Complete performance reports for all personnel.
- Release third party resources.
- Return or remove hardware and software, as appropriate.
- Return any leased or rented items or services. Terminate all associated agreements.
- Confirm release of all resources with appropriate reviews.

5.5.6 Contribute Knowledge Assets

- Submit time tracking data to the standard estimating tool used to generate the original project estimates. Submit these time tracking actuals to the estimating tool owner corresponding to the activity Update Knowledge Management database (3.7.1) given in the Table 5.5.
- Ensure completion of metrics collection in the project measurement reporting tool.
- Package and post project initiation documents such as the proposal(s) and Business Case.

- Package and post the client's requirements document. Consider including documents such as data flow diagrams, entity relationship diagrams, and a data dictionary.
- Package and post plan documents such as the Project Plan, Configuration Management Plan, Work Plan, Risk Management Plan, Project Communications Plan, Quality Management Plan, and any technical plans created.
- Package and post high-level design documents such as the conceptual design, database design, functional design, technical architecture design, and project standards.
- Package and post detailed design documents such as the flow/structure charts, pseudo-code, and program specification documents.
- Package and post source code and any other files and utilities required to create the development environment.
- Package and post-test documents such as the test plans, test approaches, test data, stubs, dummy programs, test scripts and scenarios, and test results.
- Package and post the product selection documents.
- Package and post the acceptance procedures for delivery, installation, and acceptance.
- Package and post manuals such as user manuals, installation manuals, and operations manuals.
- Package and post any other documents of interest the project management team deems potentially helpful to similar future projects.

5.5.7 Prepare and Conduct Closing Presentation

- Communicate the project's requirements, and confirm if those requirements were met as describe by the activity Final Performance Reporting (3.7.1) in Table 5.5.
- Communicate the planned vs. actual schedule and costs, as appropriate.
- Communicate on the client's and our expectations, and confirm if those expectations were met.
- Communicate the major challenges, how they were overcome, and the major successes realized.

5.5.7.1 Review Development Process and Prepare Project Closure Report

- Document the general and process-related information, including overall productivity achieved, quality delivered, processes used, process deviations, estimated and actual start and stop dates, and tools used on the project.
- Document the size and effort, including the number and complexity of software modules, peak number of FTEs, and duration in total hours, calendar days, and person-days.
- Document a summary of the defects found during the project.

- Document the causal analysis, which may lead to process improvements or be recorded as lessons learned.
- Document the knowledge assets that contributed to the organization. They are artefacts that may be useful for future projects.

6. Project Knowledge Management Areas

6.1 Project Stakeholder Management

This discusses the processes for managing stakeholders and understanding their expectations and managing them effectively. The objectives of the stakeholder management are as follows:

- Identify the project's decision makers and major influences.
- Understand the new application's business rationale.
- Confirm the target business processes.
- Confirm what the key sponsor, users, and other stakeholders want to achieve from the new application.
- Understand and create Stakeholder Expectations Matrix

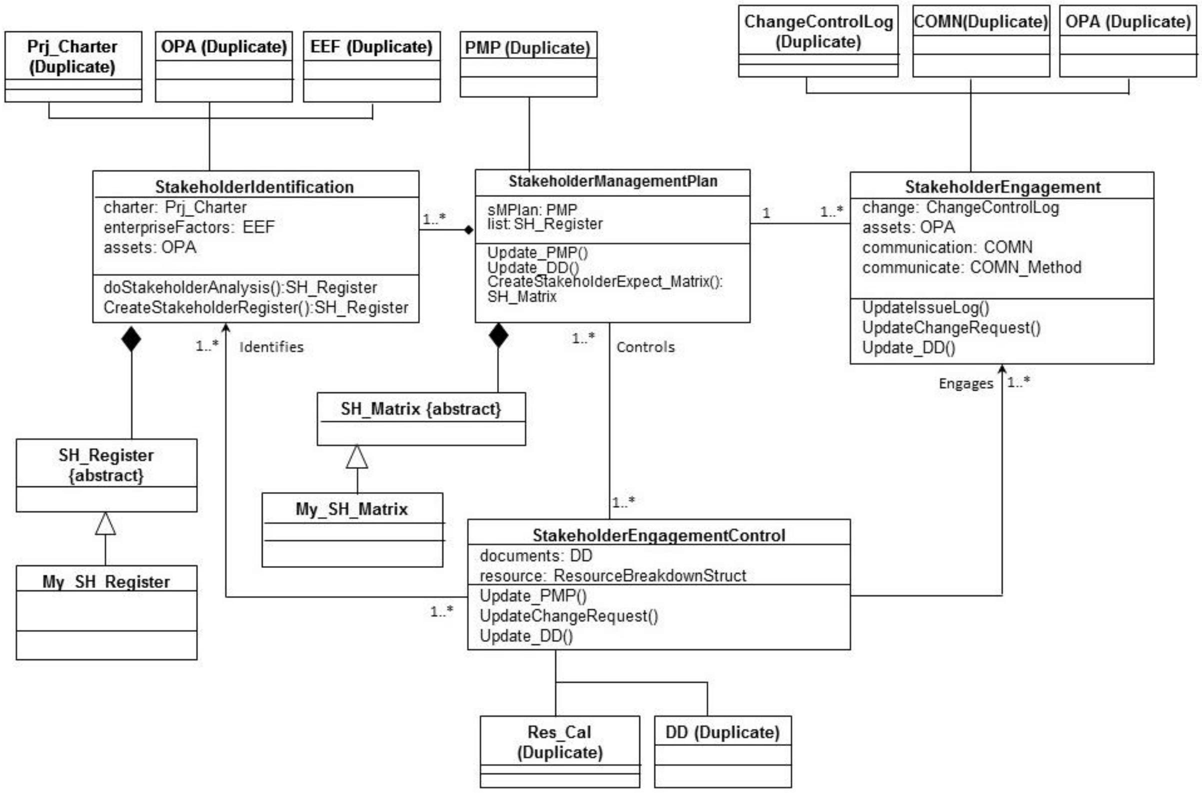


Figure 6.1 Project Stakeholder Management

Project manager should do the stakeholder analysis to identify the stakeholder and create a register to document their roles and responsibilities. This would help a project manager to manage stakeholders, communications and sharing information among different stakeholders. Expectations of stakeholders are captured in SH_Matrix.

The Issue log, Change Request document, and Deliverable Documents are updated along with overall Project Management Plan. The Stakeholder Expectation Matrix is created initially during the Plan stage to:

- Identify all stakeholder groups.
- Document stakeholder roles and responsibilities.
- Document key representatives within each stakeholder group.
- Understand stakeholder goals and expectations.
- Document any initial perceived risks, constraints, and concerns.
- Agree on a decision-making process to be used going forward.
- Agree on an approach to gaining stakeholder commitment.
- Understand the level of influence each stakeholder has on the project.
- Ensure that goals and expectations are consistent with the proposed solution.
- Agree to proceed with planning activities.

Table 6.1 Project Stakeholder Management mapping

PMBOK[1] processes and activities (section)	**Formalised Model**
Identify Stakeholders (13.1.1 - 13.1.3)	StakeholderIdentification class Operations: doStakeholderAnalysis():SH_Register CreateStakeholderRegister():SH_Register
Plan Stakeholder Management (13.2.1 -13.2.3)	StakeholderManagementPlan class Operations: Update_PMP() Update_DD() CreateStakeholderExpect_Matrix():SH_Matrix
Manage Stakeholder Engagement (13.3.1 – 13.3.3)	StakeholderEngagement class UpdateIssueLog() UpdateChangeRequest() Update_DD()
Control Stakeholder Engagement (13.4.1 – 13.4.3)	StakeholderEngagementControl class Operations: Update_PMP() UpdateChangeRequest() Update_DD()

6.1.1 doStakeholderAnalysis()

6.1.1.1 Identify Key Sponsors, Users, and Other Stakeholders

Identify and document all stakeholder groups and key representatives within each group corresponding to the activities Identify Stakeholders (13.1.1 - 13.1.3) given in Table 6.1. The term “stakeholder” is much broader than the term “sponsor.”

Though not a complete list of responsibilities, stakeholders typically include groups or individuals who complete the following:

- Sponsor the project
- Generate, review, and approve Requirements

- Participate in the decision making process
- Develop the application (e.g., project team members)
- Use the application
- Are affected by the application
- Support the application.

Key representatives from each stakeholder group are documented the PL081 Stakeholder Goals and Expectations template.

While creating the list of all stakeholders, identify key stakeholders who significantly influence the project. For example, key stakeholders can include the following:

- The project sponsor who provides the budget and is ultimately responsible for the project's success
- A user who generates Requirements and serves as a liaison between the project and end users.
- Other stakeholders who are affected by the new application such as end users, the client's customers, operations and support personnel, etc.

6.1.1.2 CreateStakeholderRegister()

Following the list created above, interview the key stakeholders to ensure the list is complete, that there are no missing stakeholders, and to document key characteristics about each stakeholder group and key representative.

Try to understand which stakeholders are enthusiastic supporters of the project and which ones may not be as supportive. Examples of the questions to ask to better understand the stakeholders include the following:

- End users. Is the audience comprised of primarily internal or external users? Address different security issues depending on the location where the audience accesses the application. The project needs to separate internal and external users.
- Support resources. Who provides long-term application and infrastructure support?
- Determine user authentication and authorization. Does the audience come from the same department? What are the profiles of these users? The answer to this question helps determine how to authenticate users and authorize their access to information and business applications. The answer also clarifies if roles are required and how many. The magnitude of the target audience that the application expects to reach determines how many network and system resources are needed.
- Define the functionality for the audience. What functionality does the audience need? Are they primarily information users? Are there business transactions? Do they publish and collaborate on information with others?
- Define the level of access. Does the audience share common resources equally, or are controls over content/data and application access varied among users? Fine-

grained access controls involve more implementation and ongoing maintenance cost, while common resources require user authentication only.

- Identify the content. Does the audience view content/data using the same frame of reference, or do different audiences require a different taxonomy and navigational cues? This answer affects implementation both for the application user interface design and for the content classification and search technologies.
- Identify the dependencies. What enterprise applications are critical to the business process? How are these applications exposed in the application? Whether applications support XML input/output or browser-based interfaces determines how much work is required to modify the applications accessed through the application.

6.1.2 CreateStakeholderExpect_Matrix()

Understand Vision and Business Objectives

Review the vision and business objectives as documented in the Project Statement of Work with the stakeholders with reference to the activities Plan Stakeholder Management (13.2.1 - 13.2.3) given in the Table 6.1. Ensure a common understanding. The vision depicts the stakeholders' view of the application to be developed, in terms of their key needs and features. It contains an outline of the envisioned high-level Requirements and serves as the contractual basis for the more detailed product Requirements.

Obtain information on the client's vision and business objectives to understand the business rationale for the project.

- Understand (in their terms) the business problems that they face and the business results they want to achieve with the application.
- Analyze if the vision and business objectives are realistic, given the state of the business and organization.
- Recognize the business measures that the client uses to determine if the new application accomplishes the business objectives. The project drives these business measures to implemented metrics.

6.1.2.1 Confirm Target Business Processes

Identify the target business processes in the form of a Business Process Blueprint, a high-level view of the key business processes. Once documented, confirm these target business processes with the stakeholders to ensure they are relevant and accurate. This initial Business Process Blueprint serves as the basis for the Identify Major Business Processes step within Define High-level Requirements and for creating the Business Process Blueprint. In this step, projects typically perform one or two levels of process decomposition where all processes are documented.

6.1.2.2 Confirm Expectations

Agree on what sponsors want from the application (in terms of business results and personal agendas), and ensure their goals and expectations are consistent with what they say the organization should achieve. Ensure their expectations are realistic and achievable. Map expectations against the current capability.

Confirm expectations around ongoing application support. Document the goals and expectations, including those for application acceptance and operational readiness in Stakeholder Goals and Expectations.

6.1.2.3 Confirm Commitment Level

Ensure the sponsor and other key stakeholders understand what it takes to achieve the business goals. Communicate what type of support the project needs, and agree on the actions that the sponsor takes to support the project. This includes securing resources for the project either as part of the project team or providing access to the client's personnel who own critical project information.

Document the agreed-upon stakeholder roles and responsibilities in Stakeholder Goals and Expectations. Stakeholder and client responsibilities may include the following:

- Project planning and execution
- Requirements development
- Requirements management
- Project monitoring and control
- Configuration management
- Quality assurance
- Verification
- Validation
- Supplier agreement management

6.1.2.4 Document Stakeholder Goals and Expectations

Review the Stakeholder Goals and Expectations with the stakeholders, and update it as required. Reflect these goals and expectations in the Business Case. Work closely with the people responsible for developing the Business Case to ensure they understand the full scope and implications of the information gathered from activities performed in this task.

Clarify the types and frequency of communication that the stakeholders are expecting, and record this information in the Project Communications Plan.

6.1.3 Stakeholder Engagement

This deliverable document stakeholder wants in terms of business results and priorities corresponding to the activities Manage Stakeholder Engagement (13.3.1 – 13.3.3) in the Table 6.1. The deliverable addresses goals, priorities, timelines, constraints, performance measures, roles, and responsibilities, and should be completed before proceeding with detailed planning. A cursory, yet accurate, understanding of these areas builds the foundation for further program/project planning, and subsequent in-depth gathering of all program/project stakeholders' expectations.

Goals and expectations should be documented relative to (but not limited to) the following:

- Initial assumptions for planning
- Business goals of the application
- Timing to achieve solution (i.e., target dates)
- Working relationships between the development team, business units, users, etc.
- Customer experience
- Financial targets
- Deliverables strategy (what deliverables are needed and when)
- Constraints to be accommodated
- Benefits that have been promised to Stakeholder
- Measures of success
- Communications
- Decision process

During project planning, confirm that all Stakeholder goals and expectations are addressed. If a goal or expectation cannot be met, document the discrepancy in the project's issue log. The project manager should be prepared to answer how the Stakeholder goals and expectations were addressed during Quality Assurance (QA) reviews as documented in the Quality Management Plan.

As the Stakeholder Goals and Expectations are updated, the Project Communications Plan must be updated. Tailor communications based on the communication needs of various Stakeholder groups. Reference and update this document throughout the project to manage expectations.

6.1.4 Stakeholder Engagement Control

During project planning, confirm that all Stakeholder goals and expectations are addressed as defined by the activities Control Stakeholder Engagement (13.4.1 – 13.4.3) given in the Table 6.1. If a goal or expectation cannot be met, document the discrepancy in the project's issue log. The project manager should be prepared to answer how the Stakeholder goals and expectations were addressed during Quality Assurance (QA) reviews as documented in the Quality Management Plan.

As the Stakeholder Goals and Expectations are updated, the Project Communications Plan must be updated. Tailor communications based on the communication needs of various Stakeholder groups.

Reference and update this document throughout the project to manage expectations.

6.2 Project Integration Management

According to PMBOK [1] Project Integration Management describes various processes and activities for developing better coordination, communication and develop synergy among various project management process groups. This helps to provide information for resources, managing alternatives and dependencies which are crucial for controlled execution and successful completion of projects.

Project Integration Management comprises the processes such as Developing the Project Charter, Develop Project Management Plan, Direct and Manage Project Work., Manage and Control Project Work, Perform Integrated Change Control, Close Project or Phase. These processes not only interact/ interoperate with each other but also with other processes in other Knowledge areas.

The Project Integration Management is required and needed because of the fact that there are many situations and scenarios where individual process interact and inter-operate.

The *ProjectMethod* Class has three attributes Project Selection, Project Methodology, and Project Info System. The *ProjectMethod* class has two operations which are SelectMethodology() and SelectMethod(). These operations are needed to select the particular methodology for a given project based on the proposed/ required criterion. Project selection methods could be Comparative Approach (Murder Board, Economic Models, Peer reviews, Benefits Compared to Cost, Scoring Models) or Constrained Optimisation (Linear Programming, Integer Programming, Dynamic Programming, Multi Objective Programming). *ProjectCharter* class uses the selected method and also gets the data from *SOW* class defined in Project Initiation process. The *ProjectCharter* class also uses classes *OrganisationProcessAssets, PMP, ChangeControl CC, PMEAS, PMPlanExecution* and *Closure* classes from process management process groups.

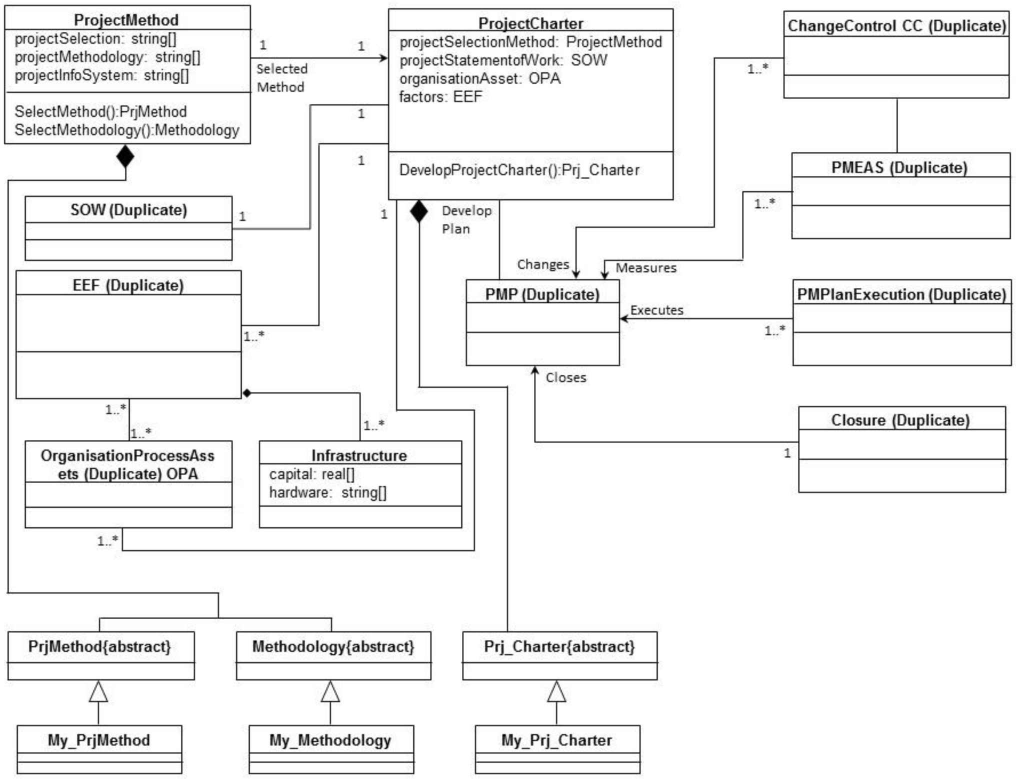


Figure 6.2 Project Integration Management

Project charter is a document which has information about the scope, objectives, stakeholders, business needs, new products, services or results which are required from the particular project. The charter takes into account information from *EEF* class used from Project Initiating Process group and *Method* Class to capture the information about company culture, facilities, infrastructure, organisation process assets and compliance standards to document the preliminary or a high level preliminary scope, timelines, objectives, assumptions, constraints, and also the business needs as well as roles of various stakeholder and any terms of reference. This document becomes guiding principle for developing project management plan and related documents.

Table 6.2 Project Integration Management mapping

PMBOK[1] processes and activities (section)	**Formalised Model**
Develop Project Charter (4.1.1- 4.1.3)	ProjectCharter Class ProjectMethod Class Operations: DevelopProjectCharter() SelectMethod() SelectMethodology()
Develop Project Management Plan (4.2.1 - 4.2.3)	PMP class (Duplicate)
Direct and Manage Project Work (4.3.1 - 4.3.3)	PMPlanExecution class (Duplicate)

PMBOK[1] processes and activities (section)	Formalised Model
Monitor and Control Project Work (4.4.1 - 4.4.3)	PMEAS class (Duplicate)
Perform Integrated Change Control (4.5.1 - 4.5.3)	ChangeControl CC class (Duplicate)
Close Project or Phase (4.6.1 - 4.6.3)	Closure class (Duplicate)

6.2.1 DevelopProjectCharter()

Project Statement of Work:

Program management issues the Project Statement of Work to the project manager. The statement of work provides the following:

- Program vision and program overview
- Information required to develop a detailed project work plan, including a description
- An indication of scope (typically in terms of work elements or deliverables)
- The program release and stage milestones within which the project must plan
- Any standard work plan templates and estimating models that apply to the project work
- The previous project work day estimate

Program management assembles this deliverable to direct project planning; they initially create it during the program planning phase. The initial estimate is an apportionment of the program costs, as captured during Demand Management. In subsequent planning iterations, the total project estimate, derived from the last baseline of the program plan, determines the initial estimate.

Project Charter is developed corresponding to the activities Develop Project Charter (4.1.1-4.1.3) defined in Table 6.2 which includes:

- **Structured management organization.** Who is the project owner? Describe the hierarchy of the project team. Identify your stakeholder groups and reflect on their input.
- **Disciplined management processes.** Provide references and documents to help both team members and stakeholders understand the project's parameters and ramifications. It's a good idea to describe project terminology. Also, identify your chosen methodology. Even if you always prefer the same methodology, you must justify why it will work for this project.
- **Project scope.** What are the costs and scheduling needs? What goals that fall outside the project scope will be achieved along the way? Are there subphases to your project?
- **Project management best practices.** Here you will identify ways to coordinate assignments, schedule team members, and track progress and costs. You will describe preferred documentation requirements.
- **Internal/external communications.** Who will meet and how often? Whether you are managing an enterprise-level project or just supervising a small team that communicates

by phone calls or emails, spell out expectations for communication methods and frequency.

6.2.1.1 SelectMethod()

Project Selection Methods are as follows:

- ➢ Benefits Measurements Methods (Comparative Approach):
  - ✓ Murder board –a panel of people who try to shoot down a new project idea
  - ✓ Peer Review
  - ✓ Scoring models
  - ✓ Economic models
  - ✓ Benefits compared to costs
- ➢ Constrained optimisation methods (Mathematical Approach):
  - ✓ Linear Programming
  - ✓ Integer Programming
  - ✓ Dynamic Programming
  - ✓ Multi-objective programming

6.2.1.2 SelectMethodology()

One of the most important functions of a methodology is to improve the effectiveness of planning, mobilizing, and ultimately executing an engagement. This document describes some basic techniques for using a methodology in the context of an engagement, and highlights the different types of methods information that are most useful in certain situations.

- Getting Value out of a Methodology
- Applying a Methodology
- Planners Versus Doers

Select which methodology or framework you will use to manage the project. It could also mean which part of the PMBOK you are going to use in a particular project.

6.2.1.3 Getting Value out of a Methodology

Methodology benefits an organization by capturing the organization’s best practices, providing a common vocabulary for the organization, and ensuring repeatability of solution delivery processes. But these organizational benefits can only be realized through the direct, tactical value that a methodology provides to the engagement teams who use it.

This “tactical value” can be measured in terms of how effectively that methodology meets the following objectives:

- Provide information to support the creation of proposals

- Allow the engagement planner to change the scope, approach, or implementation details from what is defined in the standard methodology, in order to address a specific engagement context
- Reduce the amount of time required to estimate, plan, and mobilize an engagement
- Provide deliverable templates and job aids to assist in executing the work
- Reduce an engagement's risk profile by providing a high-quality, proven approach

6.2.1.4 Applying a Methodology

During the proposal phase, typically a presentation is created that describes:

- The solution that will address a client's value proposition
- The broad approach that is to be used to deliver the solution
- A rough estimate of the time/effort/cost required to deliver the solution
- Credentials that demonstrate organization's expertise in delivering such solutions

Methodology assets can assist in the development of each of these components as follows:

- Many market offerings and other business solutions contain assets to assist in the solution definition process. While methodologies don't typically contain solution components or selling messages.
- The process-driven structure of a methodology provides an excellent way to communicate the proposed approach for the work. Consider using the methodology's top-level planning chart and/or its deliverable flow diagram to summarize the overall flow of work that will be required to deliver the solution.
- Many methodologies include estimating models that support the creation of rough estimates even when little detail is known. These models also allow you to roll up your estimates into a high level of detail, so that you can communicate approximate estimates by stage of work in the proposal.
- Though methodologies do not typically include credentials, the existence of a methodology may represent a credential of sorts. A methodology provides evidence that organization has invested in defining the approach for delivering a particular solution and has enough experience to develop a standardized process based on what project managers have learned on previous jobs.

6.2.1.5 Tailoring the Engagement Scope/Approach

Methodologies provide a common starting point for a team's plans. Engagement teams rarely apply them as-is, but instead tailor them to the specific context of their situation.

Some projects, particularly longer or larger engagements, may want to take the additional step of creating a customized, project-specific version of the methodology itself.

6.3 Project Scope Management

This describes the processes which are used to calculate the scope, and only the work required, for successful completion of the project.

This knowledge area confirms and further clarifies the project scope and ensures that the project team fully understands it before detailed project planning begins. The project scope is primarily documented in the following documents:

- Project Statement of Work
- Requirements from the Define High-level Requirements
- Solution Blueprint from the Define Solution Blueprint
- Project Description located in the Project Plan
- Project Scope Definition

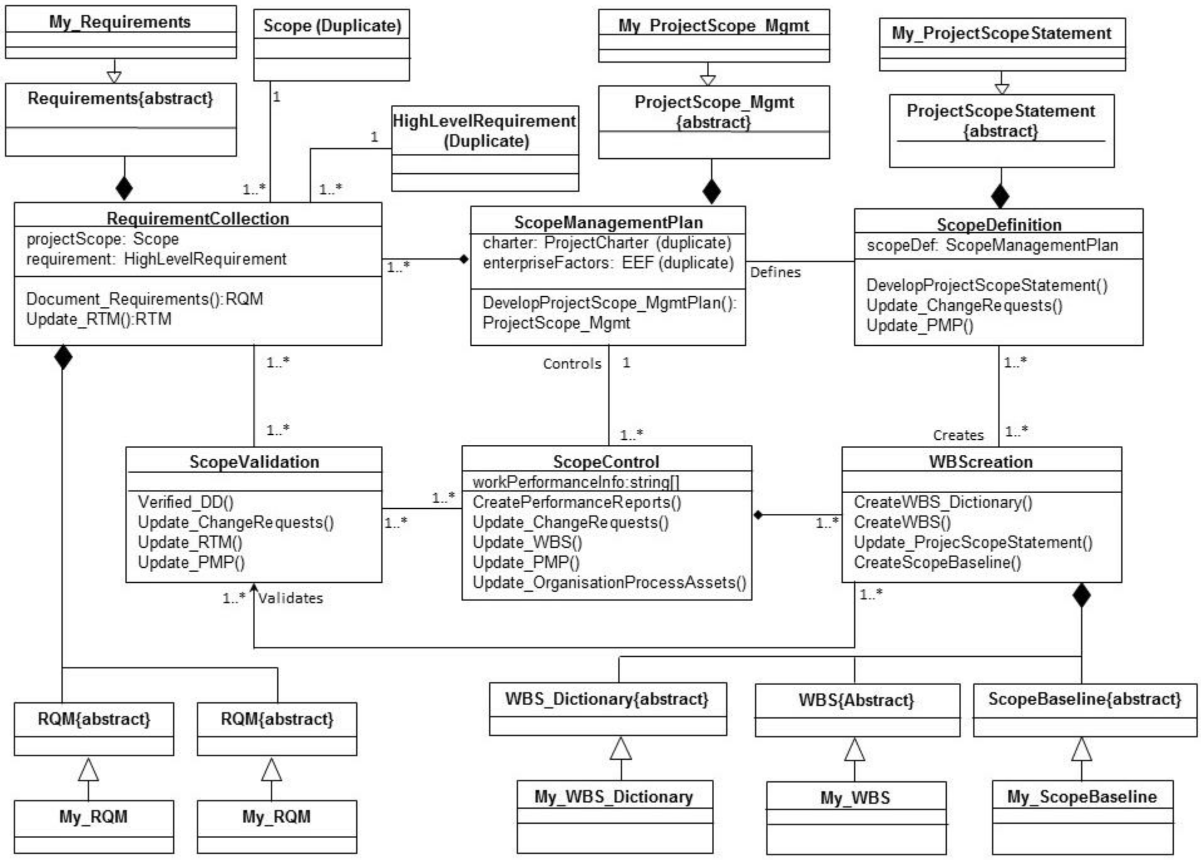


Figure 6.3 Project Scope Management

Confirm in-scope Requirements by completing the following:

- Review the major user scenarios, major business processes, and prioritized high-level requirements created during Define High-level Requirements.
- Review the Project Statement of Work to ensure the scope has not changed from when it was defined at the program level. Resolve any discrepancies.
- Additionally, ensure the appropriate stakeholders agree on out-of-scope requirements. Requirements that are deemed out-of-scope can affect requirements

that are still in-scope. Thoroughly analyse these dependencies, and adjust decisions accordingly.

- Document the project scope within the Project Scope Definition, as appropriate for the project. For example, scope can be documented in terms of business units, geographic areas, business processes, technology, people factors, and what is out-of-scope.
- Review the project scope with the appropriate stakeholders to confirm understanding and agreement.

Based on changes to in-scope and out-of-scope items, update the delivery strategy documents as needed. Review the updated Delivery Documents with the appropriate stakeholders to ensure a shared understanding of the changes.

Requirements are collected as defined in *RequirementCollection* class using data and information from *Scope* and *HighLevelRequirement* classes. The Requirement Traceability Matrix (RTM) is updated. Project Scope Management Plan is developed which provides information for defining the scope using *ScopeDefinition* class.

WBScreation class is used to create Work Breakdown Structure (WBS), WBS Dictionary and also create baselines for scope. Project Scope Statement is updated and Scope is validated through *ScopeValidation* class which provides information to *ScopeControl* class. Project scope is controlled using Scope Baseline, WBS, RTM and performance reports are created. Various other documents are updated like PMP, RTM, DD, Organisation Process Assets, and Change Requests. This helps to manage the scope of the project as described in project charter and objectives and therefore helps to successfully manage the project within the defined budget and time.

Table 6.3 Project Scope Management mapping

PMBOK[1] processes and activities (section)	**Formalised Model**
Plan Scope Management (5.1.1 - 5.1.3)	ScopeManagementPlan class DevelopProjectScope_MgmtPlan() operation
Collect Requirements (5.2.1 - 5.2.3)	RequirementCollection class Document_Requirements() operation Update_RTM() operation
Define Scope (5.3.1 - 5.3.3)	ScopeDefinition class DevelopProjectScope_MgmtPlan() operation DeveopProjectScopeStatement() operation
Create WBS (5.4.1 - 5.4.3)	WBScreation class CreateWBS_Dictionary() operation CreateWBS() operation Update_ProjectScopeStatement() operation

PMBOK[1] processes and activities (section)	**Formalised Model**
	CreateScopeBaseline() operation
Validate Scope (5.5.1 - 5.5.3)	ScopeValidation class Verified_DD() operation Update_ChangeRequests() operation Update_RTM() operation Update_PMP() operation
Control Scope (5.6.1 - 5.6.3)	ScopeControl class CreatePerformanceReports() operation Update_ChangeRequests() operation Update_WBS() operation Update_PMP() operation Update_OrganisationProcessAssets() operation

6.3.1 Confirm Project Scope

This step confirms and further clarifies the project scope and ensures that the project team fully understands it before detailed project planning begins corresponding to the activities Plan Scope Management (5.1.1 - 5.1.3) given in the Table 6.3. The project scope is primarily documented in the following documents:

- Project Statement of Work
- Requirements from the Define High-level Requirements
- Solution Blueprint from the Define Solution Blueprint
- Project Description located in the Project Plan
- Project Scope Definition

6.3.2 Collect Requirements

Confirm in-scope Requirements as defined by the activities Collect Requirements (5.2.1 - 5.2.3) given in the Table 6.3 by completing the following:

- Review the major user scenarios, major business processes, and prioritized high-level requirements created during Define High-level Requirements.
- Review the Project Statement of Work to ensure the scope has not changed from when it was defined at the program level. Resolve any discrepancies.

Additionally, ensure the appropriate stakeholders agree on out-of-scope requirements. Requirements that are deemed out-of-scope can affect requirements that are still in-scope. Thoroughly analyse these dependencies, and adjust decisions accordingly.

6.3.3 Define Scope

Document the project scope within the Project Scope Definition, as appropriate for the project corresponding to the activities Define Scope (5.3.1 - 5.3.3) given in the Table 6.3. For example, scope can be documented in terms of business units, geographic areas, business processes, technology, people factors, and what is out-of-scope.

Review the project scope with the appropriate stakeholders to confirm understanding and agreement.

Based on changes to in-scope and out-of-scope items, update the delivery strategy documents as needed. Review the updated Delivery Strategy with the appropriate stakeholders to ensure a shared understanding of the changes.

- Generate Detailed Work Estimate
- Estimating, scheduling, determining resources, planning financials, and documenting assumptions and risks are iterative in nature. Perform this step iteratively and in conjunction with

Schedule Work, Determine Resource Needs, Plan Project Financials, Document Assumptions and Risks, and Develop Management Plans.
Use the documents gathered during the Confirm Project Scope step as key inputs when generating the detailed work estimate.

Before estimating the project, gather additional supporting documents and determine work to estimate:

- Review the organisation's Delivery Methods to understand the activities performed during each project stage.
- Review the Project Statement of Work to understand what deliverables are produced throughout the project.
- Review any existing initial estimates and assumptions from the Opportunity stage.
- Review inputs from the Program Management Office (PMO), if appropriate.
- Determine specific tasks that are completed in each iteration based on the Iteration Strategy.

6.3.4 WBS

Use the appropriate estimation method based on the project scope and for the correct context. Develop WBS as per the activities Create WBS (5.4.1 - 5.4.3) given in the Table 6.3.

- Use a combination of a bottom-up and top-down approach. If the context for an estimate is a small team effort, using the deliverable-based estimator may be more appropriate. The deliverable-based estimation does not build an estimate based on the tasks and work processes; rather, the estimate is created based on a list of work objects or deliverables. The deliverable-based estimation is also known as the Design-Build-Test estimation.

Complete the following steps to generate the estimate:

- The setup tasks for the estimate is to capture the information on the Key Assumptions, and Scope worksheets.
    - Document all assumptions and comments and review key assumptions, such as contingency percentage.
    - Complete the scope questions to eliminate functions that are not in scope for the estimate. Confirm that the scope defined in the estimation matches the scope defined in the Project Plan.
    - Select the appropriate contingency control for the project.
    - Fine-tune the estimate by taking individual tasks in or out of scope or by adjusting the complexity of a task if needed. Two examples: A) Confirm that the estimated effort includes all appropriate activities directly associated with delivering the work product (e.g., programming) and activities associated with ensuring a quality work product (e.g., peer reviews, measurement and analysis, project training, etc.). B) Confirm that the project management effort includes enough time to manage the project according to best practices. For example, confirm if the effort associated with client financial and contract management is included at the program or project level & update the estimate as needed; confirm that there is enough time for quality-related activities.
    - Adjust the estimate by specifying individual task complexity levels.
- Confirm the reasonability of the overall estimate, address any issues, and iterate making updates as necessary through the following steps:
    - Compare the estimate to the project's initial estimate.
    - Compare the results against other similar projects.
    - Solicit the input of experts.
    - Solicit input from the quality and process improvement liaison.

The primary output of this step is the Detailed Estimate.

6.3.5 Schedule Work

The process of estimating, scheduling, determining resources, planning financials, and documenting assumptions and risks is iterative. Perform this step iteratively and in conjunction with estimating work, determine resource needs, document assumptions and risks, and developing management plan.

6.3.6 Develop Management Plans

Review and decompose the tasks into finer levels of detail, and determine the project milestones corresponding to the activities Validate Scope (5.5.1 - 5.5.3) given in the Table 6.3. The project milestones often coincide with completion of interim and project deliverables and are program management's primary tool for monitoring project progress.

Schedule work by completing the following:

- Based on the estimation, decompose tasks into finer levels of detail as appropriate (e.g., decompose project management and configuration management to include specific tasks like baselining, etc.). When decomposing tasks, consider the following:
    - Individual tasks are no more than two time periods in duration (one month) and are typically shorter to enable better project management and control.
    - Individual tasks are not too short in duration. When too many short duration tasks exist, the effort required to manage the Work Plan outweighs the benefit of the finer level of detail. Unfortunately, what is considered too short varies based on the project’s duration and complexity. Additionally, based on the importance of a task, some short-duration but important tasks may be included.
    - Generalizations can help guide work planning, including the 4:40/8:80 rule-of-thumb. This generalization suggests that for projects 6 months or fewer in duration, a task is not fewer than 4 hours and no more than 40 hours in duration. For projects of 12 months or longer duration, tasks are not fewer than 8 hours and no more than 80 hours in duration. Consider these generalizations and the project’s unique needs; however, at no time will individual tasks exceed two time periods (one month) in duration.
- Add additional information to tasks to better describe them based on project-specific needs.
- To understand the dependencies among the tasks (e.g., which tasks to produce first), see the Project Statement of Work.
- Sequence the tasks and associated deliverables based on the precedence of relationships.
- Determine how many tasks (and deliverables) overlap.
- Assign planned start and end dates for each task.
- Assign a date for each project milestone.
- Determine dependencies across tasks, and determine the critical path. Various critical path networking techniques were developed to help create project schedules. These techniques are especially valuable when the schedule represents an aggressively tight time frame or includes a substantial number of work activities with complex precedence relationships between work activities. When such conditions are present, consider using a formal networking technique to build and maintain the project schedule such as:
    - Critical Path Method (CPM)
    - Precedence Diagramming Method (PDM)
    - Project Evaluation and Review Technique (PERT)

- Determine the project-level critical dependencies. Typically, these dependencies require coordination with resources outside of the project team. Include these project-level critical dependencies as milestones or as linked tasks in the work plan.
- Confirm that enough lead time to procure resources exists. For example, ordering, receiving, installing, and testing servers and other hardware can take an extended amount of time that must be accounted for when scheduling work and determining dependencies across tasks.
- Confirm that placeholders exist in the work plan for the following: planned and actual start and end dates, planned and actual effort, and estimate to complete. These placeholders track the project.
- Use the dependency chart to understand how program elements depend on each other, and determine how they affect the project key dependencies.
- Use the program schedule and milestones to compare the resulting schedule with the target release date and interim stage milestones. Adjust the tasks, resource estimates iteratively, and attempt to eliminate any differences. Document the causes of remaining schedule differences.
- Update the work plan and the Deliverables/Milestones sections of the Project Plan.

The primary output of this step is an updated work Plan showing the detailed task schedule dates and milestones.

6.3.6.1 Plan Project Financials

The process of estimating, scheduling, determining resources, planning financials, and documenting assumptions and risks is iterative. Perform this step iteratively and in conjunction with estimating work, determine resource needs, document assumptions and risks, and developing management plan.

Plan project financials by completing the following:

- This estimate developed is the primary input for the Budget.
- Identify the resource based cost depending on the tasks and resources needed
- Identify the non-workforce costs and record the results in the Budget.
- Identify the costs incurred due to distributed work. Geographically distributed projects incur additional non-workforce costs associated with infrastructure, facilities, technical environments, communications needs, increased travel, etc. Record these costs in the Budget, and document how the project plans to address these additional costs in the distributed work plan.
- Identify and resolve gaps between the Budget and the project price stated in the Contract or the Project Statement of Work.

The primary output of this step is the Budget.

6.3.6.2 Document Assumptions and Risks

The process of estimating, scheduling, determining resources, planning financials, and documenting assumptions and risks is iterative. Perform this step iteratively and in conjunction with estimating work, determine resource needs, document assumptions and risks, and developing management plan.

Document the assumptions through the following steps:

- Document and confirm all assumptions that affect the project scope, estimate, work schedule, resource needs, and budget.
    - Document the assumptions in the estimation
    - Document the major project planning and estimating assumptions that must be reiterated and confirmed with the sponsors and applicable stakeholders due to their sizeable impact on the project's scope, cost, delivery approach in the project planning and estimating assumptions sections of the Project Plan.
- Review existing assumptions (e.g., assumptions from the Opportunity stage) to confirm that they are still valid. Investigate the impact, and resolve any existing assumptions that are no longer valid.
- Confirm the assumptions with the appropriate stakeholders, as identified in the Stakeholder Goals and Expectations

In accordance with the Risk Management Plan and the Risk Management procedures category, document risks in the Risk Log that are associated with the project scope, estimate, work schedule, resource needs, Budget, and distributed work, as appropriate. Reviewing existing risks (e.g., risks identified in the Risk Memo from the Opportunity stage) to confirm that they are still valid. As appropriate, investigate new risk mitigation opportunities that may now be available.

6.3.7 Develop Management Plans

Perform this step iteratively and in conjunction with confirming project scope, generating detailed estimate, and documenting Assumptions and Risks as per activities Control Scope (5.6.1 - 5.6.3) defined in the Table 6.3.

A substantial part of the Plan stage effort is devoted to planning the activities of future project stages (e.g., Analyze, Design, Build, Test, and Deploy). The results of this planning effort are documented in the project's management plans. The following five key management plans are produced during the Plan stage:

- Project Plan
- Quality Management Plan
- Project Measurement Plan
- Configuration Management Plan
- Risk Management Plan

Additionally, there are several other management plans that are also completed during the Plan Stage:

- Resource Management Plan
- Supplier Management Plan
- Project Communications Plan
- Procurement Plan
- Records Management Plan
- Knowledge Plan
- Issue Management Plan
- Security Plan

In addition to creating the management plans and associated deliverables, update the standard Peer Review Criteria and Entry/Exit Criteria to the meet the project's unique needs.

The creation of the management plans is typically an iterative process with several of the plans created in parallel as the Plan Project steps are completed. Creating the management plan involves the following:

- Gather and adapt program-level inputs if the project is under the control of a Program or Project Management Office (PMO). The PMO typically defines several approaches for the management processes necessary to support the program.
- Review the Statement of Work and other relevant information. The Statement of Work includes information on the scope of the project, timing, key resources, etc. that can be used as a starting point for the management plans.
- Review the Stakeholder Goals and Expectations to better understand the stakeholder goals, expectations, and responsibilities.
- Create the management plans.

6.3.7.1 Obtain Stakeholder Agreement

Review the planning documents with the project team leads, and confirm their agreement prior to reviewing the documents with project sponsors and other key stakeholders.

Typically, project deliverables are formally signed off at the completion of a stage of work. However, the importance and impact of the Project Plan, related management plans, and key planning documents (e.g., Work Plan) are such that they must be reviewed and signed-off by project stakeholders when they become relatively stable but before they are used as an input to subsequent activities.

To determine who approves the project planning deliverables, see the stakeholder goals and expectations.

Use this step to review the Project Plan, related management plans, and other key planning documents (e.g., Work Plan) with all relevant stakeholders, obtain sign-off, and place them under configuration management.

6.3.7.2 Organize Project Resources

This step describes the initial organization of project resources. The primary outputs of this step include an updated project organizational chart contained within the Project Plan, Roles and Responsibilities, Work Plan, Procurement Plan, and a Team Charter for each team in the project.

The project should use the project organizational chart to document the integrated team structure that best meets the project objectives and constraints. This structure could be many teams for large projects or just one team for very small projects. Document the team structure in the project organizational chart contained within the Project Plan.

Based on the specific knowledge, skills, and availability of the team resources provided by project management, determine the integrated team structure that best meets the project objectives and constraints. The project team must perform a preliminary distribution of requirements, responsibilities, authorities, tasks, and interfaces to integrated teams using the Team Charter and high-level requirements from the Requirements Traceability Matrix.

Establish and maintain a Team Charter based on the integrated team's shared vision and overall team objectives. Each team needs to develop a team charter. Keep in mind the following points when developing a Team Charter:

- Define the team's vision in the Team Charter. Define a shared vision for the integrated team that is aligned with any overarching or higher-level vision (e.g., organizational, program, etc).
- Assign team members with the right knowledge and skills to the appropriate tasks in the Work Plan. Document these assignments in the Team Charter.
- Clearly define and maintain each team member's roles and responsibilities within the Team Charter.
- Define integrated team operating procedures within the Team Charter.
- Define interfaces and collaboration among teams within the Team Charter.
- Based on the Team Charter, adjust the Work Plan to reflect actual staffing and availability.
- Based on the Team Charter, update resource needs with project management to show actual resources obtained and any resources still required.

Document the roles and responsibilities by creating a bulleted list of the duties that a resource in a specified role must perform. Create clear and easily measurable responsibilities. Include activities related to both project management (e.g., status reporting, issue/risk management, team building, and knowledge management) and traditional application development tasks as appropriate. Include time frames (e.g., daily, weekly), any tools to use, and the required technical proficiencies. Review the roles and expectations with the team member. This information can be used as an input to the performance feedback process.

Confirm supplier business relationships through the following:

- Use the company's standard procurement organization and procedures based on the project's location for contractors and leveraging company's vendor alliances.
- Create formal agreements with suppliers.
- Use the Supplier Management Plan as the basis for how you will work with the vendors or third-party contractors on the project.
- Ensure the suppliers review and provide their input into the Project Plan, creating buy-in into the plan and commitment to its successful completion.
- Ensure you and the supplier agree on performance measurement, analysis, and reporting requirements. Include both project-specific and vendor-specific requirements.
- Understand your responsibility to the Program Management Office (PMO) for verification of any supplier billing.

Select and staff team members through the following steps:

- Program management identifies potential team candidates based on role descriptions in the Resource Plan and Security Plan.
- The project manager and/or appropriate project team lead interviews and selects the team members from these candidates and advises program management of the selections.
- Program management arranges for the selected persons to be assigned to the project.
- Update the project organizational chart with the names of the actual resources who fill the identified roles.

The hardware and software procurement process can be cumbersome and time consuming; plan for it as soon as possible. Create an initial Procurement Plan to document the physical resources (e.g. facilities, computers, network, phones, etc.) and the process to acquire them. The goal is that the project obtains what it needs at the time it is needed and minimizes the risk of project delay. When planning, complete the following:

- Identify all the hardware and software products to procure. Use information from the technology capacity plan for initial hardware and software requirements.
- Determine when each product is needed. Review the Resource Plan as a high-level input, and assess when each product is needed. Confirm that the Resource Plan aligns with the Work Plan and Technology Implementation Plan.
- Determine who manages the procurement process, who is responsible for tracking the order and ensuring it is received by the right team.
- Determine when to write and submit the purchase order. Ask other programs and projects about the delivery reliability of each vendor. The plan considers the typical

delivery behaviour of each vendor before deciding when to submit the purchase order. Build extra time in the Procurement Plan to ensure the product is available when needed.

- Identify where requests are sent.
- Determine who is responsible for each product to be purchased.
- Determine who approves the order.
- Determine who receives each product.
- Determine who tests the products when they arrive. Inspect and test each product before using it for the project.
- Define support requirements.

Ensure the Work Plan allocates time for the project team members to test the hardware/software and resolve issues as they arise. Document the risks associated with the procurement process, and manage them accordingly.

The primary outputs of this step include an updated project organizational chart contained within the Project Plan, Roles and Responsibilities, Work Plan, and Procurement Plan.

6.3.7.3 Develop Project Orientation and Training Materials

Each team member needs general orientation to the project and instructions specific to their team, their role and responsibilities, and their relationship to the overall program organizational structure. This overall orientation process may include both project orientation and supplemental training on the development approach, methodology, and work environment used on the project.

Structure an orientation program that can support the initial project launch and accommodate new team members who join the project later. Recognize that some form of orientation is required for team members transferring from a prior, related project. While these team members may not need to be briefed on the project's background, objectives, or technical environment, they need to be notified of the specific goals, organization, schedule, and Work Plan used in this phase of work. Prepare a limited orientation package for them, or provide a supplement to their existing orientation materials.

Key activities in this step include the following:

- Define project policies and standards. Begin by adapting available PMO policies and standards. Place greater emphasis on policies and standards for projects with tight time frames or multiple physical locations. Tailor the detail and formality of these policies and standards based on the project’s needs and culture. Ensure your project standards reflect all relevant business and policy requirements including, but not limited to confidentiality agreements, licensing agreements, personnel policies and procedures, procurement policies and procedures, and security policies and procedures. Obtain the consensus from team leaders on the project policies and standards, and include them in the project orientation and training materials and Project Plan as appropriate (e.g., Project Tools section of the Project Plan).

- Develop a Training Needs Matrix to document the required training and its intended audience to close any knowledge and/or skills gaps. For example, this includes project-specific training, technical training, and company-required training.
- Plan orientation and training needs for team members and business representatives. Projects should leverage company’s and third-party vendor’s standard training whenever possible when planning for project training.
- Identify orientation/training sessions to be provided by program management, and arrange appropriate attendance by team members.
- Adapt orientation and training materials provided by program management for project use.
- Obtain and/or develop additional orientation/training materials as needed. Rather than duplicating information, refer team members to the original project deliverables whenever possible (e.g., the Project Plan and other management plans).
- Develop a team charter to document the team mission, composition, and responsibilities specific to the different project teams.

6.4 Project Time Management

This defines various tasks and processes for completing the project on time. The project Schedule is dependent on various parameters like activities, scope, changes, and resources. The Work Plan (at a minimum) must have the following elements:

- Activity/Milestone: Describe the task or activity to complete.
- Resources: Assigned responsibility to the resources or team members completing task
- Planned Start Date
- Planned Finish Date
- Actual Start Date
- Actual Finish Date
- Baseline Work: List the number of hours (work) originally planned to complete the activity or milestone.
- Work to Date: List the actual cumulative hours (work) spent on the activity.
- Estimate to Complete (ETC): List the number of hours the team members estimate as needed to complete the task or milestone.
- Baseline Work: is the number of hours estimated to complete a task or milestone. The baseline is set during the planning of the detailed tasks included in the Work Plan. Once set, only modify it when a Change Request or Contract change is approved.

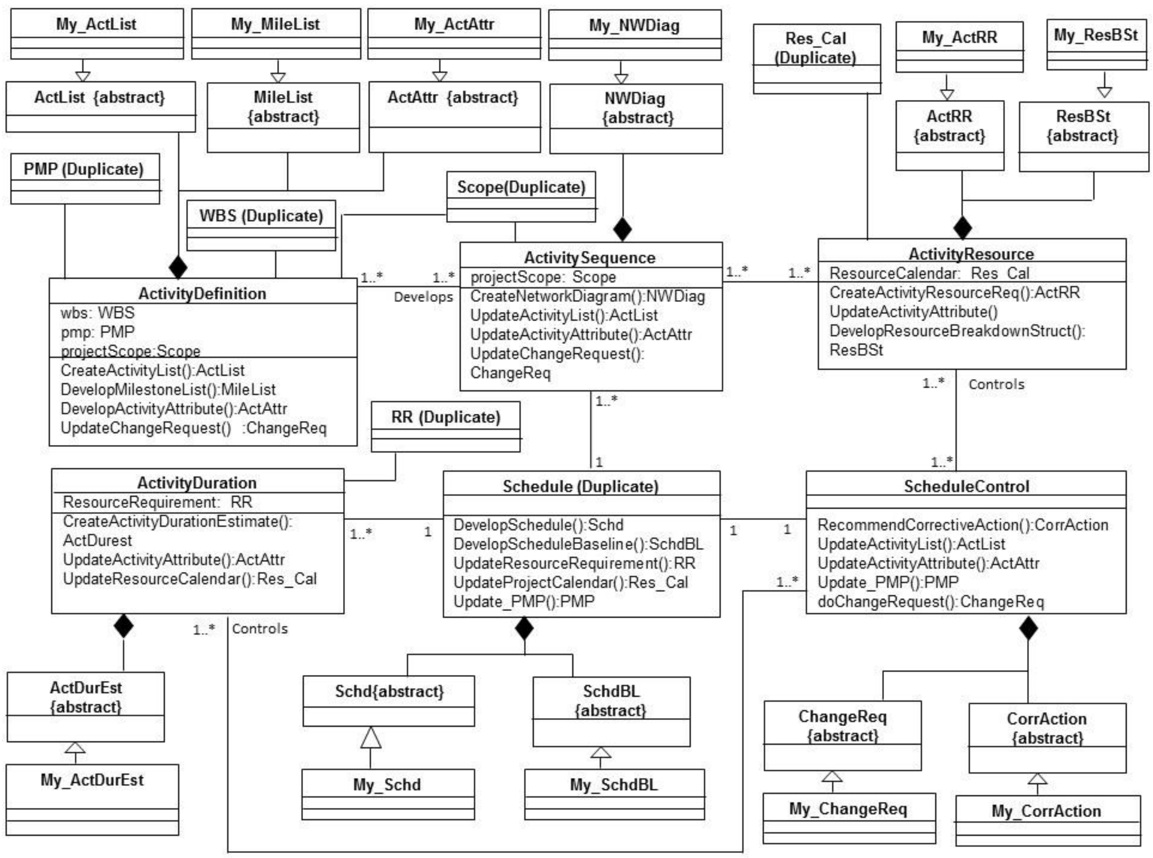


Figure 6.4 Project Time Management

All the activities to be completed for delivering the projects are defined using *Activity Definition* class. The Activity List is created defining activity attributes, and milestones. Also, the change request needs to be updated depending on the number of changes which can go in the current release. The Network Diagram is created which helps to identify the critical path for the Project Scope to be managed efficiently. Resources/ employees working on the project affect the schedule; hence the resource breakdown structure is created to identify the resource calendar, and resource skills and availability.

The schedule is created and then controlled by following the recommended corrective actions and updating the change requests and project management plan. The Project Time Management uses *ResourceRequirement* and *Schedule* class from Project Planning Process.

Table 6.4 Goal - On Time

Question	**Metric Category**	**Metric**
Are our estimates accurate?	Effort and	Project variance at completion, statistical variance at completion
Has the scope been effectively managed?	Scope management	Requirements volatility, CR impact
Are we meeting our schedule?	Schedule management	Schedule variance
Are deliverables completed on time?	Schedule management	Schedule variance
Are risks and issues managed appropriately?	Risk management	Average risk exposure
Are the review processes effective?	Process effectiveness	Peer review problem detection
Does execution of processes reflect best practices?	Process effectiveness	Best practice compliance

Table 6.5 Project Time Management mapping

PMBOK[1] processes and activities (section)	**Formalised Model**
Plan Schedule Management (6.1.1 - 6.1.3)	Schedule class (Duplicate) Operations: UpdateResourceRequirement() UpdateProjectCalendar() Update_PMP()
Define Activities (6.2.1 - 6.2.3)	ActivityDefinition class Operations: CreateActivityList() DevelopMilestoneList()

PMBOK[1] processes and activities (section)	**Formalised Model**
	DevelopActivityAttribute() UpdateChangeRequest()
Sequence Activities (6.3.1 - 6.3.3)	ActivitySequence class Operations: CreateNetworkDiagram() UpdateActivityList() UpdateActivityAttribute() UpdateChangeRequest()
Estimate Activity Resources (6.4.1 - 6.4.3)	ActivityResource class Operations: CreateActivityResourceReq() UpdateActivityAttribute() DevelopResourceBreakdownStruct()
Estimate Activity Duration (6.5.1 - 6.5.3)	ActivityDuration class CreateActivitydurationEstimate() UpdateActivityAttribute() UpdateResourceCalendar()
Develop schedule (6.6.1 - 6.6.3)	Schedule class (Duplicate) DevelopSchedule() DevelopScheduleBaseline()
Control Schedule (6.7.1 - 6.7.3)	ScheduleControl class Operations: RecommendCorrevtiveAction() UpdateActvityList() UpdateActivityAttribute() Update_PMP() ChangeRequest()

6.4.1 Planning Schedule

Estimating, scheduling, determining resources, planning financials, and documenting assumptions and risks are iterative in nature. Perform this step iteratively and in conjunction with Schedule Work, Determine Resource Needs, Plan Project Financials, Document Assumptions and Risks, and Develop Management Plans corresponding to the activities Plan Schedule Management (6.1.1 - 6.1.3) given in the Table 6.5.

Use the documents gathered during the Confirm Project Scope step as key inputs when generating the detailed work estimate.

Gather additional supporting documents and determine work to estimate:

- Review the Delivery Methods to understand the activities performed during each project stage.
- Review the Project Statement of Work to understand what deliverables are produced throughout the project.
- Review any existing initial estimates and assumptions from the Opportunity stage.
- Review inputs from the Program Management Office (PMO), if appropriate.
- Determine specific tasks that are completed in each iteration.

Use the appropriate estimation methods based on the project scope and for the correct context.

- Estimation method should use a combination of a bottom-up and top-down approach. If the context for an estimate is a small team effort, using the deliverable-based estimation may be more appropriate. The deliverable-based estimation does not build an estimate based on the tasks and work processes; rather, the estimate is created based on a list of work objects or deliverables. The deliverable-based estimation is also known as the Design-Build-Test estimation.

6.4.2 Develop a Work Plan and Budget

A Work Plan describes the key deliverables produced, the activities performed, the estimated effort required, and key completion dates at the task level corresponding to the activities Define Activities (6.2.1 - 6.2.3) given in the Table 6.. The task level is generally a sufficient level of detail both for estimating and for managing work, and it is the level where the current and the upcoming work stages are usually estimated.

The estimated amount of work for each task is based on the bottom-up estimate from company-approved estimating tools or documented historical estimates and assumptions from similar projects. The task-level defines specific tasks to perform to produce the project's deliverables. It is the basis for the project's approach and staffing requirements. Typically, work planning is driven based on the project's requirements and/or the Project Statement of Work.

When adding tasks to the Work Plan, consider critical dependencies that might exist between related tasks. For example, tasks related to application design may depend on requirements definition tasks first being completed. When such dependencies are identified, ensure they are represented in the Work Plan.

Some work planning software, such as Microsoft Project, allows linking tasks. The software then automatically adjust the properties of a linked task (e.g., Planned Start Date and Planned End Date) based on the progress of its dependencies. If the project's work planning software does not contain linking capabilities, monitor and update inter-dependent tasks manually.
The Work Plan (at a minimum) must have the following elements:

- Task/Milestone. Describe the task or activity to complete.
- Resources. Assigned responsibility to the resources or team members completing task
- Planned Start Date
- Planned Finish Date
- Actual Start Date
- Actual Finish Date
- Baseline Work. List the number of hours (work) originally planned to complete the task or milestone.
- Work to Date. List the actual cumulative hours (work) spent on the task
- Estimate to Complete (ETC). List the number of hours the team members estimate as needed to complete the task or milestone.

Baseline Work is the number of hours estimated to complete a task or milestone. The baseline is set during the planning of the detailed tasks included in the Work Plan. Once set, only modify it when a Change Request or Contract change is approved.

Work to Date is the cumulative number of hours spent on a task or milestone. Pull the hours directly from either the team members turnaround documents or other time reporting mechanism. Do not use an estimate based on the percent complete.

The Initial Estimate is initially developed during the Opportunity stage and then refined to consider external factors and contingency, experience, labour rates, and non-labour related expenses.

An estimate represents a prediction regarding the human resource effort required to complete a set of tasks related to a defined set of deliverables.

Since estimating can be performed in different ways, consider the following criteria to choose an estimation method/ tools for project use:

- Method of estimating. Consider high-level feasibility analysis, top-down estimating, and bottom-up estimating.
- Estimating results. Consider effort-based, resource-based, financial/cost, schedule, time, etc.
- Scope of work. Consider managing, planning, delivering, operating, etc.
- Type of work. Consider business integration, eCommerce, custom application development, packaged software implementation, client/server, NetCentric development, etc.

Project planning also includes the following activities:

- Configuration management planning and execution of configuration management activities, including audits

- Communication and sponsorship planning and execution of communication and sponsorship activities, such as status meetings, status reporting, project training delivery, etc.
- Measurement activities, including collection, analysis, and reporting

There are additional project management plans to include in the Project Plan. If a project finds it more effective, they may group all project management items into a single Project Plan. Alternatively, they may choose to list them separately. Possible items for inclusion in the Project Plan include, but are not limited to, the following:

- Quality review planning and execution of quality review activities, including execution of peer reviews, process and product quality assurance (PPQA) reviews, best practices reviews, and quality assurance (QA) reviews
- Risk management planning and execution of risk management activities
- Administrative items, such as status reporting, time tracking, QPI support, etc.
- Track Project Schedule/Time Process
- Schedule and time monitoring track the project's progress toward its deadlines and ensures the project meets its deadline and budget expectations.
- Figure 6.5 identifies the process for monitoring schedule and time on a project.

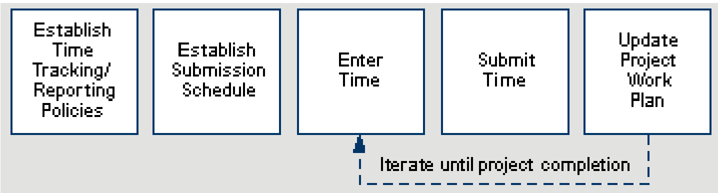


Figure 6.5 Monitoring Schedule and Time

6.4.3 Establish Time Tracking/Reporting Policies

- Project management establishes time tracking/reporting policies for the project. The established policies must be consistent with organizational and/or contract-related policies and procedures. The policies and procedures include information on how the project tracks time at the task or milestone level. In addition, if the project utilizes subcontractors, the project addresses how subcontractors track/report time they spend on project activities. Project time tracking/reporting policies are typically located with the project's documented administrative standards, policies, and procedures.
- Establish Submission Schedule
- Project management establishes a schedule for the time spent on activities in the Work Plan. Project management may choose to establish a schedule that is consistent with the organizational time submission procedures. The submission schedule reflects the frequency which project the management team needs access to time spent on tasks in the Work Plan (e.g., on the 15th and end of month; bi-weekly, etc.).
- Enter Time

- For a given time period, the individual team member/subcontractor enters the time spent on tasks in the Work Plan in the project's turnaround document and/or other project time tracking tool according to the established schedule and policy. The turnaround document can be presented in various formats (e.g., Microsoft Word, Microsoft Excel, Microsoft Access) and must list the exact tasks listed in the Work Plan.
- The project must specify where the time tracking tool is located. The individual team member reviews the time entered before submitting it to the repository.
- Submit Time
- For a given time period, the individual team member/subcontractor submits the completed turnaround document and/or other project time tracking tool to the defined repository according to the established schedule and policy.
- Update Project Work Plan
- The Work Plan is updated based on time submissions received from team members/ subcontractors.

6.4.4 Determine Resource Needs

The process of estimating, scheduling, determining resources, planning financials, and documenting assumptions and risks is iterative. Perform this step iteratively and in conjunction with Generate Detailed Work Estimate, Document Assumptions and Risks, and Develop Management Plans corresponding to the activities Define Activities (6.2.1 - 6.2.3), Sequence Activities (6.3.1 - 6.3.3), Estimate Activity Resources (6.4.1 - 6.4.3) and Estimate Activity Duration (6.5.1 - 6.5.3) given in the Table 6.5.

Complex projects create a Resource Plan to aid in the planning process. For projects of limited resource complexity, the Resource Plan is optional. The resource functions of Microsoft Project, may be sufficient for simple personnel resource planning. Additionally, projects with limited other, non-personnel resource complexity can use the Logistics and Infrastructure section of the Project Plan to record non-personnel resources. The balance of this step assumes the development of a Resource Plan.

Determine the types of roles and associated knowledge and skills needed to perform the estimated work. Use the output from the estimator as a starting point. For each type of role, roughly determine the number of resources needed to complete the estimated work based on the estimated time required and project time frame. Load this high-level resource estimate into the Resource Plan and Work Plan.

Consider using resources from other workgroups within the company, onshore/offshore delivery centre personnel, client personnel, and third parties to fill the identified roles.

Document the resulting workforce mix in the Project Plan, Resource Plan, and Work Plan.

Program management subsequently reviews, approves, and acts on these resource needs.

The process of estimating, scheduling, determining resources, planning financials, and documenting assumptions and risks is iterative. Perform this step iteratively and in conjunction with Generate Detailed Work Estimate, Determine Resource Needs, Document Assumptions and Risks, and Develop Management Plans.

After generating and exporting the estimate, import the initial Work Plan into Microsoft Project. Review and decompose the tasks into finer levels of detail, and determine the project milestones. The project milestones often coincide with completion of interim and project deliverables and are program management's primary tool for monitoring project progress.

Schedule work by completing the following:

- Decompose tasks into finer levels of detail as appropriate (e.g., decompose project management and configuration management to include specific tasks like baselining, etc.).
  When decomposing tasks, consider the following:
  - Individual tasks are no more than two time periods in duration (one month) and are typically shorter to enable better project management and control.
  - Individual tasks are not too short in duration. When too many short duration tasks exist, the effort required to manage the Work Plan outweighs the benefit of the finer level of detail. Unfortunately, what is considered too short varies based on the project's duration and complexity. Additionally, based on the importance of a task, some short-duration but important tasks may be included.
  - Generalizations can help guide work planning, including the 4:40/8:80 rule-of-thumb. This generalization suggests that for projects 6 months or fewer in duration, a task is not fewer than 4 hours and no more than 40 hours in duration. For projects of 12 months or longer duration, tasks are not fewer than 8 hours and no more than 80 hours in duration. Consider these generalizations and the project's unique needs; however, at no time will individual tasks exceed two time periods (one month) in duration.
- Add additional information to tasks to better describe them based on project-specific needs.
- To understand the dependencies among the tasks (e.g., which tasks to produce first), see the Project Statement of Work.
- Sequence the tasks and associated deliverables based on the precedence of relationships.
- Determine how many tasks (and deliverables) overlap.
- Assign planned start and end dates for each task.

- Assign a date for each project milestone.
- Determine dependencies across tasks, and determine the critical path. Various critical path networking techniques were developed to help create project schedules. These techniques are especially valuable when the schedule represents an aggressively tight time frame or includes a substantial number of work activities with complex precedence relationships between work activities. When such conditions are present, consider using a formal networking technique to build and maintain the project schedule such as:
    - Critical Path Method (CPM)
    - Precedence Diagramming Method (PDM)
    - Project Evaluation and Review Technique (PERT)
- Determine the project-level critical dependencies. Typically, these dependencies require coordination with resources outside of the project team. Include these project-level critical dependencies as milestones or as linked tasks in the Work Plan.
- Confirm that enough lead time to procure resources exists. For example, ordering, receiving, installing, and testing servers and other hardware can take an extended amount of time that must be accounted for when scheduling work and determining dependencies across tasks.
- Confirm that placeholders exist in the Work Plan for the following: planned and actual start and end dates, planned and actual effort, and estimate to complete. These placeholders track the project.
- Use the Dependency Chart to understand how program elements depend on each other, and determine how they affect the project key dependencies.
- Use the Program Schedule and Milestones to compare the resulting schedule with the target release date and interim stage milestones. Adjust the tasks, resource estimates, etc. iteratively, and attempt to eliminate any differences. Document the causes of remaining schedule differences.
- Update the Work Plan and the Deliverables/Milestones sections of the Project Plan.

The primary output of this step is an updated Work Plan showing the detailed task schedule dates and milestones as per the activities Develop schedule (6.6.1 - 6.6.3) given in the Table 6.5.

After determining the project resource needs, develop the project organizational chart contained within the Project Plan. This chart is a hierarchical breakdown of the project team that shows primary reporting responsibilities and lines of authority. The team organization reflects proper consideration and balancing of the following factors:

- Type of work. Aggregate tasks with similar skill requirements. Assign related work requiring complex integration to a minimum number of people to reduce coordination and integration issues. Assign highly skilled, specialized work to a minimum number of people to reduce the need for deeply skilled team members.

- Team size and internal structure. Aggregate closely related work within teams, and recognize the span of control limits. Consider using work cells, high-performance teams, and other team approaches to reduce the number of deliverable hand-offs and to provide clear ownership of the deliverables created. For example, work cells are work groups that include individuals who are responsible for producing a significant deliverable, contain all of the skills and resources needed to perform their assigned work, and are located close together.

After determining the needed resources and the project organization, use the Work Plan and Resource Plan to perform detailed resource loading by completing the following:

- Establish a time period (e.g., week, month, etc.) for allocating the estimated resources.
- Allocate the resources to the time periods by role/type/skill. Allocate resources at less than 100% of the available time for project activities to enable participation in non-project activities like meetings, recruiting, mentoring, training, vacation, etc.
- Level the resource loads to eliminate or reduce the peaks and valleys for the estimated work by adjusting task duration, adjusting staffing levels, creating new work packages, revising resource estimates, re-sequencing work packages, creating new work packages, and/or revising the schedule and milestones if necessary.
- Update the affected plans as necessary based on the extent of changes required during resource loading (e.g., new milestones, revised schedule, change in the distributed work model, etc.)
- Communicate significant adjustments to program management. Changes can affect the program-level milestones, effort/cost, and workspace and support resources.

In addition to determining the workforce needs, ensure the project has the appropriate facilities and tools to do the job by determining the project's physical resource needs. For example, this can include office work space, conference rooms, computers, servers, network connectivity, printers, software, phones, office supplies, etc. Consider the lead times to acquire physical resources, and begin the procurement process, if applicable.

Consider additional physical resource needs associated with a distributed workforce, if applicable. For example, these additional resource needs can include infrastructure, facilities, technical environments, communications needs, etc. Identify and document the high-level description, quantity needed, and dates needed as appropriate in the Resource Plan for physical resources. If known, document the additional details for items procurement in the Procurement Plan.

The primary outputs of this step are the Resource Plan (documents the project resource requirements at a high level), the project organizational chart contained within the Project Plan (updated if more or fewer resources are needed), the Project Schedule and Milestones and the Deliverables/Milestones sections of the Project Plan (if milestones changed), and the Work Plan (updated with detailed resource requirements).

6.5 Project Cost Management

This describes process for estimating, planning, budgeting and controlling the cost of the project. Since cost one of the triple constraint and hence one of the most important for making a project successful.

Project Charter documents high level objectives, time, cost, scope, assumptions, constraints and other dependencies of the project this is important part of *CostManagement Plan* class. The Cost Management Plan is dependent on Enterprise Environmental Factors which is based on the company objectives and the budget available. The Resource Requirements and Work Breakdown Structure along with scope are main attributes of the *CostEstimate* class. The Sponsor for the project is decided and funds are allocated for the project. The Budget is determined based on the Cost Management Plan, Risk, and Organisation Process Assets. Cost Baseline is calculated and the Budget is controlled as per the project objectives. The Configuration Management Plan is updated along with Project Management Plan

The Cost is controlled using earned value management system and doing the reserve analysis. For any project to be completed successfully cost has to be controlled within the budget and funds available. Hence the cost of project must be controlled and managed actively and efficiently.

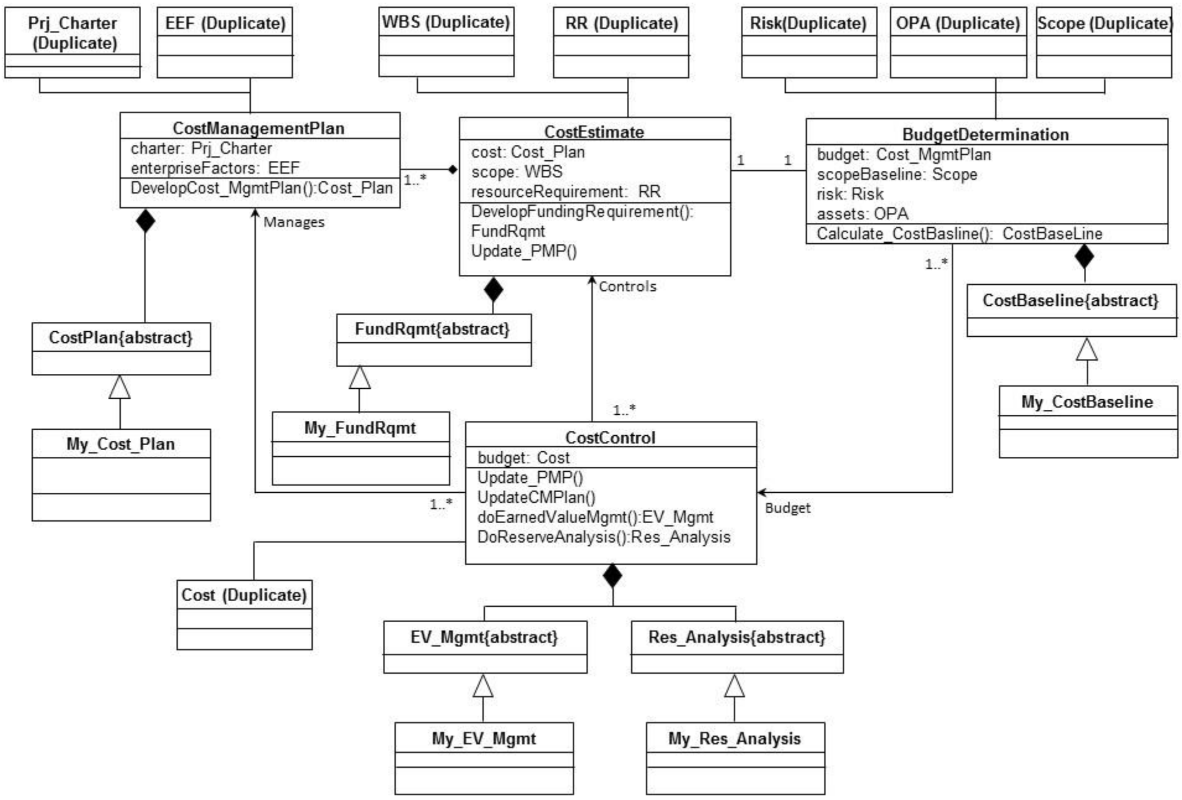


Figure 6.6 Project Cost Management

Table 6.6 Goal - On Budget

Question	Metric Category	Metric
Are estimates accurate?	Effort and cost	Project variance at completion, statistical variance at completion
Are we on budget?	Effort and cost	To complete performance index
Are we profitable?	Profitability	Cost variance
Are we working efficiently?	Work efficiency	Cost performance index

Table 6.7 Project Cost Management mapping

PMBOK[1] processes and activities (section)	**Formalised Model**
Plan Cost Management (7.1.1 - 7.1.3)	CostManagementPlan class DevelopCost_MgmtPlan():Cost_Plan
Estimate Costs (7.2.1 - 7.2.3)	CostEstimate class Operations: DevelopFundingRequirement(): FundRqmt Update_PMP()
Determine Budget (7.3.1 - 7.3.3)	BudgetDetermination class Operation Calculate_CostBaseline(): CostBaseLine
Control Costs (7.4.1 - 7.4.3)	CostControl Class Operations: Update_PMP() UpdateCMPlan() doEarnedValueMgmt():EV_Mgmt DoReserveAnalysis():Res_Analysis

6.5.1 DevelopCost_MgmtPlan()

Corresponding to the activities Plan Cost Management (7.1.1 - 7.1.3) in the Table 6.7 develop cost management plan. Critical Questions for estimate:

- Has the estimate, for both days and costs, been evaluated by experts from the delivery centres?
- Have you involved deal services on the project planning and costing for multi-year deals with delivery centres?

- Have you allocated enough time and budget for the delivery centre personnel to be trained in functional application areas and other specific process/tools related as dictated by the engagement?
- Do you have a training and knowledge transfer plan, including time allocation and implementation budget?
- Are the estimates accurate, accounting for risk factors such as lack of communication, resource availability, technology differences, etc., which are common in multi-site development?
- Have you allocated enough contingencies to account for the effort needed to transition deliverables between sites?
- Are all key areas covered in the estimates: analysis, design, build, test, etc.?
- Have you built in the cost associated with running the project office and reporting and tracking project actuals?
- Have you involved experts from all sites, technical and functional, to assist the estimating?
- Have you allocated budgets across organizations/locations and assigned responsibilities for deliverables?
- Have you considered expenses for travel, communication between sites, etc.?
- Have you involved experts in costing multi-site development projects, including all resources?
- For costing the project, have you involved the delivery centre experts in providing rate, tax, multi-year inflation adjustments, etc. into the cost calculations?
- Have you considered any pre-existing master services agreement conditions that you may already have with the client in terms of pricing this new deal?
- Have you accounted for currency and inflation risks (expenses will be through local currency)?

6.5.2 DevelopFundingRequirement()

Determine Resource Needs:

The process of estimating, scheduling, determining resources, planning financials, and documenting assumptions and risks is iterative. Perform this step iteratively and in conjunction with Generate Detailed Work Estimate, Document Assumptions and Risks, and Develop Management Plans corresponding to the activities Estimate Costs (7.2.1 - 7.2.3) given in the Table 6.7.

Complex projects create a Resource Plan to aid in the planning process. For projects of limited resource complexity, the Resource Plan is optional. The resource functions of Microsoft Project, may be sufficient for simple personnel resource planning. Additionally, projects with limited other, non-personnel resource complexity can use the Logistics and Infrastructure section of the Project Plan to record non-personnel resources. The balance of this step assumes the development of a Resource Plan.

Determine the types of roles and associated knowledge and skills needed to perform the estimated work. Use the output from the estimator as a starting point. For each type of role, roughly determine the number of resources needed to complete the estimated work based on the estimated time required and project time frame. Load this high-level resource estimate into the Resource Plan and Work Plan.

Consider using resources from other workgroups within the company, onshore/offshore delivery centre personnel, client personnel, and third parties to fill the identified roles. Document the resulting workforce mix in the Project Plan, Resource Plan, and Work Plan. Program management subsequently reviews, approves, and acts on these resource needs.

After determining the project resource needs develop the project organizational chart contained within the Project Plan. This chart is a hierarchical breakdown of the project team that shows primary reporting responsibilities and lines of authority. The team organization reflects proper consideration and balancing of the following factors:

- Type of work. Aggregate tasks with similar skill requirements. Assign related work requiring complex integration to a minimum number of people to reduce coordination and integration issues. Assign highly skilled, specialized work to a minimum number of people to reduce the need for deeply skilled team members.
- Team size and internal structure. Aggregate closely related work within teams, and recognize the span of control limits. Consider using work cells, high-performance teams, and other team approaches to reduce the number of deliverable hand-offs and to provide clear ownership of the deliverables created. For example, work cells are work groups that include individuals who are responsible for producing a significant deliverable, contain all of the skills and resources needed to perform their assigned work, and are located close together.

After determining the needed resources and the project organization, use the Work Plan and Resource Plan to perform detailed resource loading by completing the following:

- Establish a time period (e.g., week, month, etc.) for allocating the estimated resources.
- Allocate the resources to the time periods by role/type/skill. Allocate resources at less than 100% of the available time for project activities to enable participation in non-project activities like community meetings, recruiting, mentoring, training, vacation, etc.
- Level the resource loads to eliminate or reduce the peaks and valleys for the estimated work by adjusting task duration, adjusting staffing levels, creating new work packages, revising resource estimates, re-sequencing work packages, creating new work packages, and/or revising the schedule and milestones if necessary.

- Update the affected plans as necessary based on the extent of changes required during resource loading (e.g., new milestones, revised schedule, change in the distributed work model, etc.)
- Communicate significant adjustments to program management. Changes can affect the program-level milestones, effort/cost, and the need for workspace and support resources.

In addition to determining the workforce needs, ensure the project has the appropriate facilities and tools to do the job by determining the project's physical resource needs. For example, this can include office work space, conference rooms, computers, servers, network connectivity, printers, software, phones, office supplies, etc. Consider the lead times to acquire physical resources, and begin the procurement process, if applicable.

Consider additional physical resource needs associated with a distributed workforce, if applicable. For example, these additional resource needs can include infrastructure, facilities, technical environments, communications needs, etc. Identify and document the high-level description, quantity needed, and dates needed as appropriate in the Resource Plan for physical resources. If known, document the additional details for items procurement in the Procurement Plan. For more information on procuring non-personnel resources, see the Organize Project Resource step.

The primary outputs of this step are the Resource Plan (documents the project resource requirements at a high level), the project organizational chart contained within the Project Plan (updated if more or fewer resources are needed), the Project Schedule and Milestones and the Deliverables/Milestones sections of the Project Plan (if milestones changed), and the Work Plan (updated with detailed resource requirements).

6.5.3 Calculate_CostBaseline()

Plan Project Financials

The process of estimating, scheduling, determining resources, planning financials, and documenting assumptions and risks is iterative. Perform this step iteratively and in conjunction with estimating work, determine resource needs, document assumptions and risks, and developing management plan as per the activities Determine Budget (7.3.1 - 7.3.3) given in the Table 6.7.

Plan project financials by completing the following:

- Generated estimate acts as the primary input for the Budget.
- Using the resource costs and budgets, identify the costs associated with the workforce from the Determine Resource Needs step, and record the results in the Budget.
- Identify the non-workforce costs from the Determine Resource Needs step, and record the results in the Budget.

- Identify the costs incurred due to distributed work. Geographically distributed projects incur additional non-workforce costs associated with infrastructure, facilities, technical environments, communications needs, increased travel, etc. Record these costs in the Budget, and document how the project plans to address these additional costs in the Distributed Work Management Plan.
- Identify and resolve gaps between the Budget and the project price stated in the Contract or the Project Statement of Work.

The primary output of this step is the Budget.

6.5.4 doEarnedValueMgmt()

Gather Metrics Data

Gather Team Status and Metrics Data involves the following:

- Collect individual Status Report, team Status Report, and information from project management tools and deliverables to get status information.
- Track actuals; schedule, resource, effort, budget or financials against the Work Plan.
    - Track actuals and identify variance between planned vs. actual hours spent on tasks.
    - Identify tasks that are over budget or past due. Highlight tasks that are over budget or past due in the Status Reports.
    - Track financials. If cost rates are already in the Work Plan, use the Work Plan to track costs. Otherwise, see project financial tracking sheet to obtain the financial data.
- Capture metrics data as outlined in the Project Measurement Plan. Gather metrics data from project reporting documents such as turnaround documents (T-Doc), individual and team project status reports, project financial report, peer review feedback, SIR and change requests, risk management tool and other sources. Enter data in the measurement reporting tool. The core set of metrics include:
    - Cost Performance Index - Effort (CPI)
    - Schedule Performance Index - Effort (SPI)
    - Peer Review Efficiency
    - Peer Review Problem Detection
    - Resolution Time Performance
    - Response Time Performance

Consider using a measurement reporting tool to track project execution.

6.5.4.1 Analyze Metrics and Report Project Status

Analyse metrics to understand the progress of the project and how efficiently and effectively the work effort meets the project objectives and the stakeholder expectations. Use the Project Measurement Plan to understand how the metrics will be analysed and reported.

This step involves the following:

- Check the quality of the data. The quality of the analysis and the ability for decision makers to trust the analysis is dependent on the quality of the data. Some of the criteria considered essential are consistent data in types and categories, accurate data and data with a consistent unit of measures.
- Analyse metrics for trends, inconsistencies, out-of-bounds data values, and reasonableness at least twice a month. Analyse and determine causes for those metrics with results outside the specification limits or those with trending or one sided results. The project manager should discuss and develop an action plan to address those causes.
- Analyse the interrelationships among the metrics gathered for indirect project impacts.
- Monitor progress and performance metrics on an ongoing basis. The project manager uses the measurement reporting tool and the following reports to monitor and control the project:
    - Status Report
    - Project Staffing Report
    - Issue Log
    - Change Control Log
    - Risk Log
    - Configuration Management Status Report
- Report project status and measurement and analysis results to all relevant stakeholders in a timely fashion to support accurate assessment of status, decision making and corrective action. Document project status using the project status report template for the Status Report. Monitor project commitments against those identified in the project plan.
- Conduct status meetings to communicate project status, issues, and metrics analysis to the appropriate level of management and stakeholders and create meeting minutes. Stakeholders include project team members, client, and other people external to the team (vendor, subcontractor, contract management, etc.).

When actual status deviates from the plan, the project manager needs to take the appropriate steps to get the project back on track. The project manager identifies the corrective actions, and tracks them through closure. If the Work Plan needs to be updated, the project manager goes through the appropriate configuration management process as defined in the Configuration Management Plan.

6.5.4.2 doReserveAnalysis()

The difference between the maximum funding and the end of the cost baseline is Management Reserve. Cost Estimations have to include the contingency funding as costs to overcome unforeseen circumstances which are anticipated but not certain events. These funds are available at the discretion of the manager to deal with such events to manage the project costs.

6.6 Project Quality Management

This defines the processes for assuring that the project is delivered as per the required standard and objectives. PMBOK has proposed that along with triple constraints Quality is also one of the other three constraints which the organisations should manage effectively so that they are able to deliver good quality projects, products, services or results. Managing and controlling the quality of projects, products, services or results delivered plays important role in today's competitive world.

The purpose of quality activities (e.g., quality reviews, testing, and validation) is to ensure that projects provide business value, meet client expectations, and that quality deliverables are delivered to the client.

- Quality, validation, and verification activities verify that the project will deliver on the following items:
- Business goals and expectations. Provide high client satisfaction by understanding how clients define success.
- Team goals. Provide the team with a clear sense of direction by clarifying goals and expectations.
- Financial goals. Manage costs by implementing efficient, effective, and repeatable procedures, processes, and standards.
- Quality goals. Minimize problems (e.g., errors, defects, and faults) and re-work by carefully verifying and validating the work at each stage.
- Delivery goals. Improve speed, quality, and cost of delivery by continuously improving the project.
- Additionally, quality reviews are used for the following purposes:
- Verify that processes and deliverables/work products comply with project standards and procedures.
- Identify and remove defects in deliverables/work products early and efficiently.
- Verify the proper progression of client engagements.
- Verify adherence to CMMI requirements

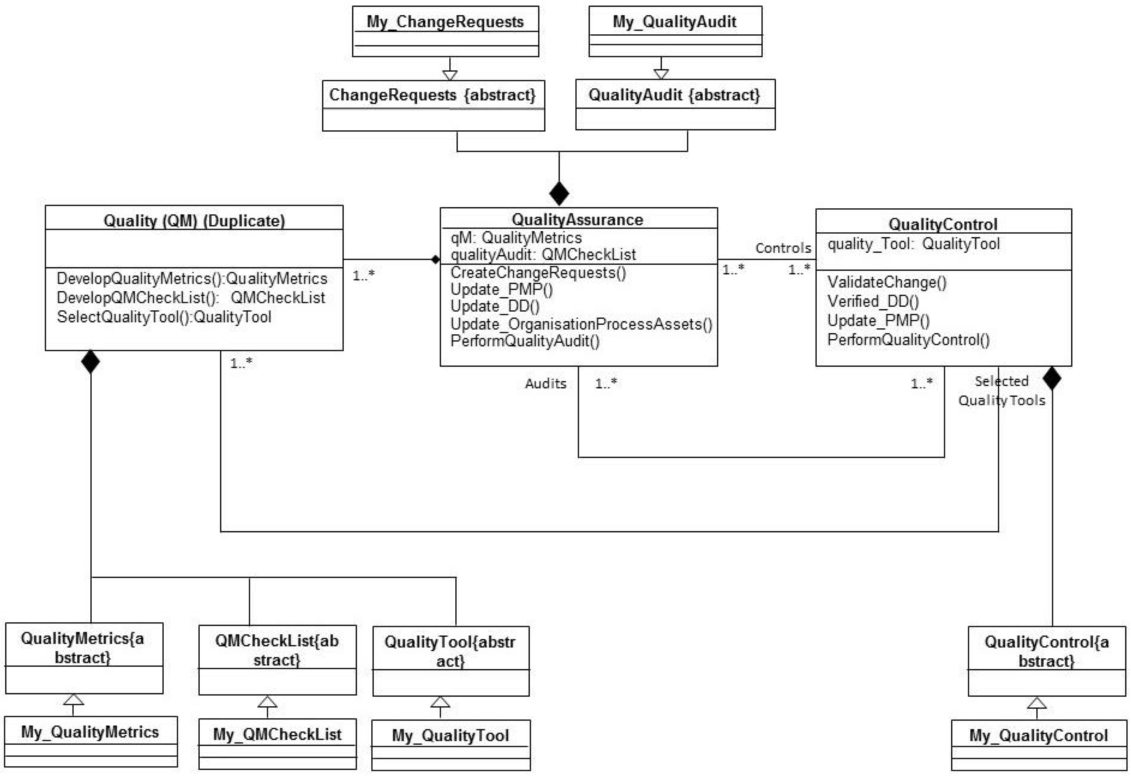


Figure 6.7 Project Quality Management

Quality Management is used to develop Quality Metrics, QM Check Lists and select an appropriate tool for measuring, controlling, and managing quality. The project management plan, deliverable documents and organisational process assets. The quality control audits are performed at regular intervals as per the plan and also according to the external schedule of certifications/ compliances/ regulations. This ensures that organisation is adhering to the industry standards and regulations. Good quality control process ensures that client would have better confidence in the services/ projects/ products/ or results delivered by the organisation.

Table 6.8 Goal - High Quality

Question	**Metric Category**	**Metric**
What is the quality of our products?	Product quality	Peer review problem category percentage, fault detection
Are we working efficiently?	Work efficiency	Cost performance index, productivity
Are the review processes effective?	Process effectiveness	Peer review problem detection
Does execution of processes reflect best practices?	Process effectiveness	Best practice compliance
Are customers satisfied?	Customer satisfaction	Help desk response rate

Table 6.9 Project Quality Management mapping

PMBOK[1] processes and activities (section)	**Formalised Model**
Plan Quality Management (8.1.1 - 8.1.3)	Quality (QM) class Develop_QualityMetrics() operation DevelopQMCheckList() operation SelectQualityTool() operation
Perform Quality Control (8.2.1 - 8.2.3)	QualityAssurance class CreateChangeRequests() operation Update_PMP() operation Update_DD() operation Update_OrganisationProcessAssets() operation PerformQualityAudit() operation
Control Quality (8.3.1 - 8.3.3)	QualityControl class Validate_Change() operation Verified_DD() operation Update_PMP() operation PerformQualityControl() operation

6.6.1 Quality Management

Quality management is a systematic approach consisting of processes, procedures, techniques, and standards for ensuring the:

- Quality of project deliverables created by the project team
- Application of best practices and techniques that minimize risks to project quality, schedule, and budget
- Delivery of consistent results in terms of quality, schedule, and budget across multiple projects
- Comprehension of stakeholder expectations, with a clearly outlined approach to meet those expectations

Use this document to plan and implement the quality management effort for your project corresponding to the activities Plan Quality Management (8.1.1 - 8.1.3) given in the Table 6.9.

A. Purpose of Quality

The purpose of quality activities (e.g., quality reviews, testing, and validation) is to ensure that projects provide business value, meet client expectations, and that quality deliverables are delivered to the client.

Quality, validation, and verification activities verify that the project will deliver on the following items:

- Business goals and expectations. Provide high client satisfaction by understanding how clients define success.

- Team goals. Provide the team with a clear sense of direction by clarifying goals and expectations.
- Financial goals. Manage costs by implementing efficient, effective, and repeatable procedures, processes, and standards.
- Quality goals. Minimize problems (e.g., errors, defects, and faults) and re-work by carefully verifying and validating the work at each stage.
- Delivery goals. Improve speed, quality, and cost of delivery by continuously improving the project.

Additionally, quality reviews are used for the following purposes:

- Verify that processes and deliverables/work products comply with project standards and procedures.
- Identify and remove defects in deliverables/work products early and efficiently.
- Verify the proper progression of client engagements.
- Verify adherence to CMMI requirements

B. Roles and Responsibilities

Typically, project management sets the scope and direction of quality review planning. Project management is responsible for ensuring quality reviews are conducted in a continuous process throughout the project life cycle.

Major roles include the following:

- The client director and project manager provide overall direction.
- The issue manager, project manager, quality manager, and team members plan the development and execution.
- The project manager, team leads, the quality and process improvement liaison, and team members participate in quality reviews.
- The team leads, metrics leads, and the quality and process improvement liaison report quality measures.

Project Roles and Responsibilities - Overview

- Develop and maintain the quality review process.
- Develop and maintain the deliverables/work products undergoing quality reviews.
- Identify the deliverables/work products applicable to quality reviews.
- Ensure compliance of processes and deliverables/work products to project standards and procedures.
- Discuss upcoming quality reviews during project meetings.
- Identify and remove defects in the deliverables/work products early and efficiently.
- Verify the progression of client engagements.
- Document and report issues and defects.
- Participate in quality reviews.
- Track System Investigation Requests (SIRs) and Change Requests (CRs), and reduce them as the work effort progresses.

- Verify that the specification package meets all requirements (e.g., business needs, explicit and implicit user requirements, etc.).
- Verify that project requirements were correctly transformed into code.

Project Roles and Responsibilities - Examples

Examples of responsibilities include the following:

Project Manager Roles and Responsibilities

Project managers are responsible for the following:

- Budget time to conduct quality reviews, including peer reviews and designating the process' participants.
- Determine which work products to review.
- Review the recommended changes, and determine if review of the rework is necessary.
- Analyse the peer review results (as outlined in the Project Measurement Plan), and assess the effectiveness of the review process.

Work Product Owner Roles and Responsibilities

The work product owner is responsible for the following:

- Create the work product to review.
- Prepare the work product according to defined work product standards.
- Record peer review results, and publish the minutes.
- Review the recommended changes with the team lead.
- Understand and make the necessary corrections, and document those resolutions.
- Document the time spent on peer reviews and correcting defects.
- Provide feedback on how to improve the peer review process.

Facilitator Roles and Responsibilities

The facilitator is responsible for the following:

- Determine the peer review's logistics.
- Facilitate the review process.
- Examine the review materials beforehand.
- Confirm that all issues were documented, and collect metrics from the participants.
- Confer with participants to schedule time for a follow-up review session, if needed.
- Record the time spent on peer reviews.
- Provide feedback on how to improve the peer review process.

Meeting Recorder Roles and Responsibilities

The meeting recorder is responsible for the following:

- Create meeting minutes, and forward those minutes to the work product owner.
- Record the time spent on peer review.
- Provide feedback on how to improve the peer review process.

Reviewer(s) Roles and Responsibilities

Reviewers can be anyone with a vested interest in the work product moving on to the next stage of development and could include the functional architect, technical architect, database administrator, system integrator, or an owner from the previous development stage. Team leads determine the appropriate people to be involved with the peer review at the various stages.

The reviewer must possess the skills to evaluate the deliverable and recommend changes. The reviewer is responsible for the following:

- Examine the review materials before the review session.
- Include points for clarification.
- Provide constructive criticism to the document owner.
- Follow the facilitator's rules and directives.
- Provide feedback on how to improve the peer review process.

6.6.2 Plan Stakeholders

Successful implementation of any change journey depends on the commitment of the people involved in or responsible for delivering the change and its resourcing and acceptance. Effective stakeholder identification is a critical step to performing successful stakeholder management throughout the project/program journey.

Key factors to consider when identifying stakeholders include the following:

- Their stature in the organization and the amount of power or influence they wield or perceive they wield in future events
- How they perceive the change
- Their stakeholder role
- Their level of involvement in the change process
- The impact of the change on their roles and responsibilities
- Contextual factors: their understanding of the change process, their competency, and their capability, motivation, morale, and change resilience
- If the challenges differ significantly from the capabilities they possess
- How the change progresses
- Their personal operating styles

Taking the above factors into account will help support the identification of the right stakeholders for the Quality Management Plan. As the change journey develops and business context develops, identify and manage any needed new stakeholders.

For more information on the management of stakeholder goals and expectations, see Stakeholder Management.

6.6.3 Plan and/or Process Dependencies

In the event that changes are made to the Quality Management Plan, update any planning and/or process dependencies with other related documentation. This process seeks to ensure that end-to-end consistency exists.

If changes to the Quality Management Plan are made, update the following plans/processes if needed:

- Project Measurement Plan
- Project Plan
- Configuration Management Plan
- Risk Management Plan

6.6.4 Verification

Verification ensures a deliverable is correctly derived from the inputs of the corresponding stage and is internally consistent. In addition, it checks that both the output and the process conform to the standards outlined in the project's Quality Management Plan corresponding to the activities Perform Quality Control (8.2.1 - 8.2.3) given in the Table 6.9. Verification ensures that the project built it correctly and that the deliverable conforms to the project standards for architecture, design, coding, and testing. Verification attempts to catch problems as early as possible in the development life cycle and ensures the specifications are complete, correct, and adhere to standards.

Verification includes most testing efforts (excluding user acceptance testing, which is a Validation activity). It also includes most quality reviews, although QA reviews may contain a validation and a verification purpose.

6.6.4.1 Testing

Most types of testing are verification activities. Testing ensures that the specifications were implemented properly and that the solution meets the business and performance requirements. Verification is conducted through the component, assembly, performance, product, user acceptance, and operational readiness tests.

The project determines which types of testing it conducts. Capture this information in a Test Approach. See the table 6.10 for a sample list of verification activities.

Table 6.10 Verification Activities

Project Phase/ Stage	Test Type	Documentation Required	Conducted By
Test	Component Test	Test Approach, Test script and test results	Test Lead
Test	Assembly Testing	Test Approach, Test script and test results	Test Lead
Test	Performance	Test Approach, Test script and test results	Test Lead

Project Phase/ Stage	Test Type	Documentation Required	Conducted By
Test	Product Testing	Test Approach, Test script and test results	Test Lead
Test	User Acceptance Testing	Test Approach, Test script and test results	Product Testing Team
Test	Operational Readiness	Test Approach, Test script and test results	Workforce Performance Team

6.6.4.2 Quality Review

Quality review activities (e.g., peer review, process and product quality assurance (PPQA) review, and QA review) involve a number of reviewers, each with specific responsibilities for verifying aspects of the agreed deliverables. Examples include functional completeness, adherence to standards, and ensuring the correct use of the technology infrastructure. The PPQA review contains both a product and process review, whilst the latter (process) review would typically include a best practice management tool review. The quality review is discussed in more detail in a subsequent section of this deliverable. The quality review is primarily a verification activity, although QA reviews also serve a validation purpose.

6.6.4.3 The V-Model

V-Model can be typically used to perform verification and validation activities. The V-Model is a framework used to achieve stage containment by organizing the verification, validation, and testing in and across all of the methodology elements throughout the delivery phase of the methodology. The V-Model is a coordinated and integrated process of verification, validation, and testing as outlined in Figure 6.8.

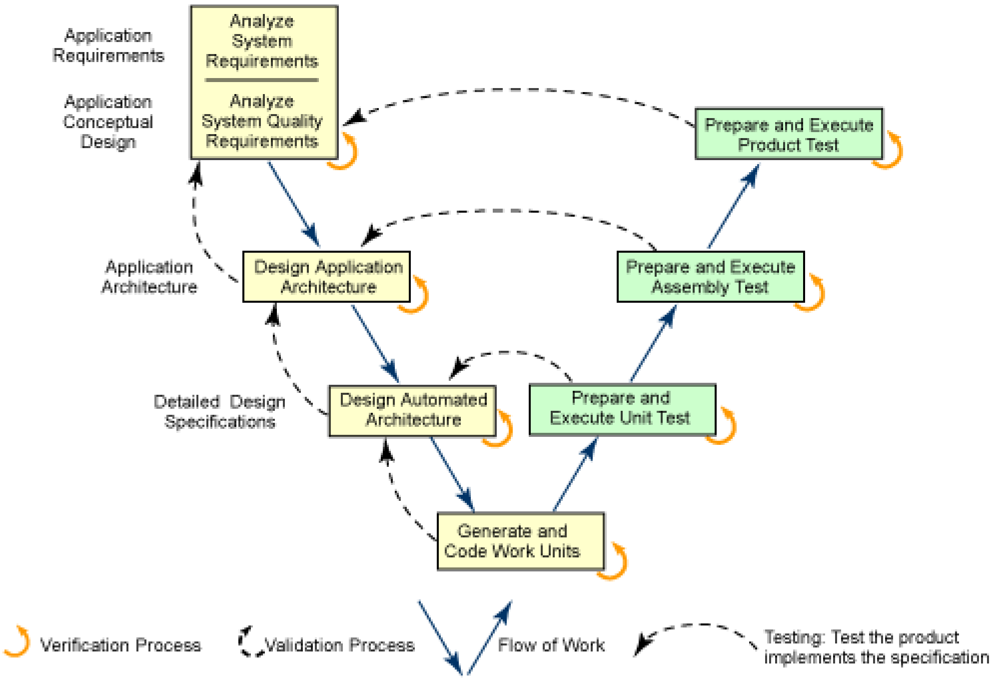


Figure 6.8 V-Model

6.6.4.4 Validation

Validation is performed to ensure the system/product being developed can be used as it was intended in its operating environment. Validate specifications to ensure the development process is still on track to provide a solution that meets the requirements and the Business Case.

There are two parts to planning validation tasks: approach and preparation. The validation approach determines which validation techniques to use at each stage, defines the roles and responsibilities associated with these techniques, and selects appropriate tools for automating the execution. The preparation for validation consists of creating the documentation necessary to perform the inspection.

Validation is performed on various work products throughout the development life cycle including requirements, design, and prototypes. Work products that are chosen for validation must represent how system/product being developed will satisfy the user's needs. Validation activities include user acceptance testing, prototyping, joint application development (JAD) sessions, design walkthroughs/workshops, demonstrations, and the conference room pilot. Typically, end-users conduct validation.

Validation can be performed to ensure the system being developed can be used as it was intended in its operating environment. validate specifications to ensure the development process is still on track to provide a solution that meets the requirements & the Business Case.

6.6.4.5 Validation Approach

Validation is performed on various work products throughout the development life cycle. Validation focuses on requirements and design, with use of prototypes to ensure the correct product is being built.

6.6.4.6 Validation Items and Acceptance Criteria

Requirements of the project will be validated through the conference room pilot. Acceptance criteria include the needs outlined in the Business Case and user requirements.

Design(s) of the project will be validated through prototyping and joint application development sessions. Acceptance criteria include ease of use, performance, and look and feel. Business Case for the project will be validated through user acceptance testing.

See the table 6.11 below for a sample list of validation activities:

Table 6.11 Validation Activities

Project Phase/ Stage	Validation Technique	Conducted By
Analyse	Functional Prototypes	Analyse Team (with client or user group)
Design	Joint Application Design (JAD) Sessions	Design Team (with client or user group)
Build	Conference Room Pilot	Design Team, Workforce Performance Team
Test	Operational / Deployment Pilot	Testing Team (with client or user group)
Test	User Acceptance Test	Testing Team (with client or user group)

When issues are discovered in validation, analyse the issues to determine the issue's origination point. Once identifying the point of origin, send the issue back to that area of origination for resolution and possible process correction.

6.6.4.7 Quality Review Process

The quality review process consists of verification and validation activities involving the following two steps:

- Plan for quality reviews. During this step, allot time for quality reviews. Identify the deliverables/work products and processes to review. Determine the type of quality review to conduct for each deliverable/work product. In addition, determine the review schedule and documentation process. Identify and notify reviewers and reviewees.

Determine the technique for quality reviews, such as a facilitated peer review meeting or an unfacilitated peer review.

- Execute the quality review. During this step, quality reviews are executed according to established processes. Quality reviews are conducted, necessary rework is performed, and results are analyzed.

6.6.4.7.1 Plan for Quality Reviews

Planning for reviews encompasses the following tasks:

6.6.4.7.1.1 Identify Deliverables/Work Products

The project determines the complexity, criticality, and size of the deliverables/work products subject to quality reviews. Review all deliverables/work products that make up the system to deliver. This sets the baseline for expectations and allows for a structured timetable to be created. Projects plan for quality reviews in all stages of the project life cycle.

6.6.4.7.1.2 Determine Type of Review

The type of quality review to perform for each deliverable/work product and the review technique are determined as part of this step. The types of quality reviews and the deliverables/work products reviewed include the following.

Peer Reviews

A peer review is any review where an individual completes a deliverable/work product or a component of a larger deliverable/work product and is ready for a project team member to examine the deliverables/work product to identify problems and areas where changes are needed. Perform a peer review on all deliverables and work products.

Peer review is only performed on completed deliverables/work products or completed sub-portions of deliverables/work products. Types of peer review include peer, team lead, design review board, and manager reviews. Peer reviews are mostly conducted for content review, but they also ensure that defined standards and formats are followed. Peer reviews are a CMMI Level 3 requirement and are required for all projects.

Use a Peer Review Feedback Form to document all reviews. To determine what constitutes the correct percentage of work effort for a particular project or stage, see the measurement reporting tool. For any deviations, see the operation group's Quality Management Plan.

During a peer review, project team members review documents such as detailed design and application code to identify issues, risks, and defects and to recommend changes as needed. Peer reviews are typically performed on deliverables/work products during the following times:

- Before they migrate to the next development phase
- Before delivery to the client or user groups
- Before the product due date

- Before undergoing major reviews such as the process and product quality assurance (PPQA) review

Peer reviews provide the following benefits:

- All team members become familiar with a consistent review process and with the project's standard review criteria.
- The ability to evaluate work of others is enhanced.
- Reviewers learn about the work of others, thus broadening their views of the overall program.
- Problems are detected earlier, reducing the number of problems discovered in later stages.

Either of the following techniques can be used to conduct peer reviews:

- Facilitated Meeting. The work product/deliverable owner and all the peer reviewers meet either face-to-face or via a conference call to discuss, identify, and document problems. The peer reviewers read the work product, criteria, and standards and prepare comments before the meeting; however, they do not document all problems or issues in the Peer Review Feedback Form. The problems are documented on the Peer Review Feedback Form either during the meeting or afterwards by the recorder or other designee.
- Unfacilitated Peer Review. The work product/deliverable owner provides the peer reviewers with a hard copy or electronic copy of the work product/deliverable and asks the reviewer to submit problems either documented directly on the work product/deliverable or on a Peer Review Feedback Form. Only peer reviewers who are qualified and understand the material participate in an unfacilitated peer review. After reviewing the feedback received from the reviewers, the work product/deliverable owner determines if a meeting is necessary to clarify any identified problems. The deliverable/work product owner documents or references problems on the Peer Review Feedback Form.

6.6.4.8 Process and Product Quality Assurance (PPQA) Reviews

A PPQA review is a methodical examination of work products, project management processes, high-level development processes, and day-to-day practices by an objective reviewer to ensure compliance to the project's documented processes and standards. PPQA reviews are conducted from a functional perspective by the project's quality and process improvement (QPI) liaison. In some cases, a subject matter expert (SME) with functional knowledge of the deliverable/work product may conduct a PPQA review. PPQA reviews are a CMMI Level 3 requirement and are required for all projects.

PPQA reviews include both product and process reviews:

- Product PPQA Review. The work product/deliverable owner provides the PPQA reviewer with a hard copy or electronic copy of the work product/deliverable and asks the reviewer to submit problems documented directly on the PPQA Review Report.

After reviewing the feedback received from the reviewer, the work product/deliverable owner determines if a meeting is necessary to clarify any identified problems. The PPQA reviewee closes out the PPQA Review Report. The product element of the PPQA reviews are conducted on key work products such as the five QPI management plans (Project Plan, Configuration Management Plan, Risk Management Plan, Quality Management Plan, and Project Measurement Plan).

- Process PPQA Review. The project's QPI liaison typically conducts a process PPQA review (also known as a best practice review) on the project's Project, Risk, Quality, Measurement, and Configuration Management plans periodically throughout the project. This reviews the project processes that comply with standards put in place by our company's QPI team. This review ensures that projects deliver high-quality client service by developing, maintaining, and deploying best practices, methodologies, tools, and knowledge capital using the Capability Maturity Model Integration (CMMI) framework. This review also ensures that projects maintain 100% compliance with organisation's quality policy and frameworks.

6.6.4.9 Quality Assurance (QA) Reviews

QA reviews have an experienced director from within the company who is external and objective to the engagement formally review the client engagement as described in the activities Control Quality (8.3.1 - 8.3.3) given in the Table 6.9. The QA review is a review component within the Global Business Development Framework (GBDF). The GBDF provides an agreed-upon set of principles, management processes, forms, and standard terminology to employ consistently across all operating groups when selecting clients and developing relationships and opportunities with those clients. The review aims to verify that each client engagement is progressing based on client expectations, will bring business value to the client, and deliver the solution on time and within budget.

6.6.4.9.1 Identify Reviewers

Identify reviewers who will participate in the quality reviews. The reviewer's responsibilities include the following:

- Participate in reviews.
- Examine the review materials before the review session.
- Provide points for clarification.
- Provide constructive criticism to the deliverable/work product owner.
- Follow the facilitator's rules and directives.
- Provide feedback on the review process.
- Ensure deliverables/work products adhere to the appropriate standards.
- Recommend changes to procedures to improve processes.

Team leads select the peer reviewers. PPQA reviewers are generally the project's QPI liaisons or are selected based on their expertise with the technology or deliverable type. The project's QPI liaison can provide information on locating a PPQA reviewer.

The Peer Review and PPQA Review sections of this document list the roles and responsibilities for each review type.

6.6.4.9.2 Determine Review Schedule

Determine a review schedule for the quality reviews. During the initial stage of project planning, the project provides a-high level schedule of the quality reviews in the Work Plan. As the project approaches each phase or deliverable/work product due date, update the schedule with actual dates. A deliverable/work product may go through two forms of reviews, so allow time for reviews and rework prior to the due date.

See the table 6.12 below for a sample quality review schedule.

Table 6.12 Quality Review Schedule

Project Phase/ Stage	Deliverable / Work Product	Type of Quality Review	Rate of Review	Timing of ReviewDocumentation Required	Documentation Required	Reviewer	Review Technique
Manage	Project Plan	PPQA (Product)	ALL	A week before the deliverable/ work product due date	PPQA Report	Process Improvement (QPI) Liaison	PPQA Review
Manage	CM Plan	PPQA (Product)	ALL	More than 5 days before the deliverable/ work product due date	PPQA Report	QPI Liaison	PPQA Review
Manage	Best Practices Matrix	PPQA (Process)	ALL	Monthly	Best Practices Management Tool	QPI Liaison	BP Review
Design	Design Document	Peer Review	100%	More than 5 days before the deliverable/ work product due date	Peer Review Feedback Form	Design Review Board	Facilitated Peer Review Meeting
Design	Requirements	PPQA (Product)	100%	More than 5 days before the deliverable/ work product due date	PPQA Report	QPI Liaison	PPQA Review

Project Phase/ Stage	Deliverable / Work Product	Type of Quality Review	Rate of Review	Timing of ReviewDocumentation Required	Documentation Required	Reviewer	Review Technique
Design	Test Plan	Peer Review	ALL	More than 5 days before the deliverable/ work product due date	Peer Review Feedback Form	Team Lead	Unfacilitated Peer Review
Design	Test Scripts	Peer Review	75%	More than 5 days before the deliverable/ work product due date	Peer Review Feedback Form	Manager	Facilitated Peer Review Meeting
Build and Test	Code	Peer Review	60%	More than 5 days before the deliverable/ work product due date	Peer Review Feedback Form	Developer	Facilitated Peer Review Meeting
Deployment	Deployment Plan	QA	ALL	More than 5 days before the deliverable/ work product due date	Quality Assurance Memo	QA Director	QA Review

6.6.4.9.3 Determine Review Documentation

During this step, determine the required documentation and format that will be produced during quality reviews. Determine the process used to collect base measure data (e.g., metrics), as outlined in the Project Measurement Plan. The project determines the standards for reviewing the deliverables/work products and documents the standards in a checklist, such as the Peer Review Criteria.

- Peer Review. The project uses the Peer Review Feedback Form/peer review tools to capture review documentation. The data captured in the Peer Review Feedback Form or tools is incorporated in the peer review worksheet in the project measurement reporting tool and in the Peer Review section of the individual/team level Status Report.
- PPQA Review. The project uses the PPQA Review Report to capture review documentation.
- QA Review.

6.6.4.9.4 Execute Quality Reviews

Executing quality reviews encompasses the following tasks:

- Prepare for Quality Reviews. Establish standards and criteria. Prepare deliverables/work products. Contact participants. Distribute materials and standards to the reviewers.
- Conduct Quality Reviews. Document the problems (errors and defects) in the deliverable being reviewed. Facilitate the quality review discussion, and share comments and recommendations. Collect measurements, including the time spent preparing for and participating in the quality review, the number of problems discovered, and other measurements as outlined in this plan and the Project Measurement Plan.
- Perform Necessary Rework. Perform rework as recommended by the reviewers. Monitor the status of defects, issues, risks, and action items. Record the resolution and any changes made to the deliverable/work product.
- Analyse the Quality Review Results. Evaluate and review the results of the quality review as indicated in the Project Measurement Plan. Analyse any recorded metrics. Periodically evaluate the project execution of the quality review process. Use peer review data to identify areas for process improvement or where corrective action may be necessary.

Each of these tasks is performed during each type of quality review. The tasks were summarized by each review type for convenience.

6.6.4.10 Peer Review

6.6.4.11 Schedule Peer Review

Determine a review schedule for peer reviews. During the initial stage of project planning, the project provides a high-level schedule of quality reviews in the Work Plan. As the project approaches each phase or deliverable due date, update the schedule with actual dates.

6.6.4.12 Prepare for Peer Review

After planning for peer reviews, the project prepares for the peer review.

The deliverable owner’s responsibilities include sending the deliverable/work product and the Peer Review Feedback Form to the peer reviewers at least two days prior the review. Consider sending the Peer Review Criteria to the reviewers.

The peer reviewer’s responsibilities include understanding the Peer Review Criteria, reading the deliverable/work product prior to the review meeting, and documenting comments for the deliverable/work product.

6.6.4.13 Conduct Peer Review

After preparing for the peer review, the project conducts the peer review using the technique identified during planning. This step recommends changes to the deliverable/work product noticed by peer reviewers. Conduct the review five days prior to the due date.

For development efforts, peer review all requirements, design, code, and testing work products. At least 60% of the work effort for each stage requires the peer reviews be documented in the Peer Review Feedback Forms.

For maintenance efforts, peer review all deliverables. At least 25% of the work effort of all requests (SIRs and enhancements) taking 4 or more hours to fix must have peer reviews documented in the Peer Review Feedback Forms.

Roles and responsibilities for the facilitated peer review meeting technique include the following:

The deliverable/work product owner:

- Participate in the Peer Review discussion.
- Clarify deliverable questions.
- Document the time spent on peer reviews.
- Provide feedback on the peer review process regarding improvements and changes to the team lead or project manager.
- Appoint a facilitator and a meeting recorder.

The facilitator:

- Facilitate the peer review process.
- Keep the review focused on deliverable/work products, not on the owner.
- Organize logistics of the peer review.
- Examine the review materials before the review.
- Confirm that all issues are documented and measurements collected from the participants.
- Confer with participants to schedule time for a follow-up review session, if needed.
- Provide feedback on the peer review process regarding improvements and changes to the team lead or project manager.

The meeting recorder:

- Document meeting minutes, and deliver those minutes to the deliverable/work product owner.
- Record the time spent on peer review for all participants.
- Document the problems (errors and defects) in the Peer Review Feedback Form.
- Deliver the Peer Review Feedback Form to the deliverable/work product owner.
- Provide feedback on the peer review process regarding improvements and changes to the team lead or project manager.

The peer reviewers:

- Provide recommendations, comments, and changes to the deliverable/work product using the Peer Review Criteria.
- Provide constructive criticism on the deliverable/work product being reviewed.

- Follow the facilitator's rules and directives.

Roles and responsibilities for the unfacilitated peer review technique include the following:

The deliverable/work product owner:

- Clarify deliverable questions with the peer reviewer as necessary.
- Document problems (errors and defects) in the Peer Review Feedback Form.
- Document the time spent on the peer review in the Peer Review Feedback Form.
- Provide feedback on the peer review process regarding improvements and changes to the team lead or project manager.

The peer reviewers:

- Provide recommendations, comments, and changes to the deliverable/work product using the Peer Review Criteria.
- Provide constructive criticism on the deliverable/work product being reviewed.
- Contact the peer reviewee to discuss disagreements, if necessary. If a resolution cannot be reached with the peer reviewee, the issue escalates to the project manager.
- Provide feedback on the peer review process regarding improvements and changes to the team lead or project manager.

Only peer reviewers who are qualified and understand the material to review conduct an unfacilitated peer review.

6.6.4.14 Perform Necessary Rework

The next step is performing any necessary rework.

The deliverable/work product owner:

- Perform necessary rework, as suggested in the Peer Review Feedback Form.
- Record the resolution in the Peer Review Feedback Form.
- Document the time spent correcting problems (defects and errors).
- Monitor the status of problems (defects and errors).
- Forward the peer review metrics to the project's team lead or metrics lead.

The team lead reviews the changes with the deliverable/work product owner.

Multiple peer reviews may be conducted for the same work product. If scheduling several reviews, use a single Peer Review Feedback Form to capture data for all peer reviews of the work product.

6.6.4.15 Analyze Review Results

The final step of the peer review process is to analyse the review's results. The team lead submits the peer review metrics to the project manager or metrics lead for analysis. Peer review data are is analysed, as indicated in the Project Measurement Plan.

The team lead:

- Review individual Peer Review Feedback Forms for possible recording errors.

- Ensure all peer review data are entered into the individual/team-level Status Report.
- Analyse peer review metrics, as indicated in the Project Measurement Plan.
- Raise any issues indicated by the metrics to the project manager.

The project manager or metrics lead:

- Ensure all peer review data are entered into the measurement reporting tool.
- Analyse the peer review, as indicated in the Project Measurement Plan.
- Evaluate the project's execution of the peer review process.
- Identify areas for process improvement or areas where corrective action may be necessary.
- Document the corrective action in the project measurement reporting tool and as an issue in the project's issue tracking tool.

6.6.5 Process and Product Quality Assurance (PPQA) Review

6.6.5.1 Prepare for PPQA Review

After planning, prepare for PPQA review.

For a products PPQA review, the PPQA reviewee:

- Send the deliverable/work product to PPQA reviewer.
- Send the evaluation criteria/standards to PPQA reviewer.
- Send the PPQA Review Report template to the PPQA reviewer.

For a products PPQA review, the PPQA reviewer:

- Review the deliverables.
- Document the recommendations and issues in the PPQA Review Report.

For a process PPQA review (best practices review), the PPQA reviewee:

- Send the process document to PPQA reviewer.
- Send the PPQA Review Report template to PPQA reviewer.

For a process PPQA review (best practices review), the PPQA reviewer:

- Review the process document.
- Document the recommendations and issues in the PPQA Review Report.

6.6.5.2 Conduct PPQA Review

The PPQA reviewer:

- Send feedback to PPQA reviewee in the PPQA Review Report.
- Contact the PPQA reviewer to schedule a meeting, if necessary.
- Conduct a meeting, if necessary.
- Update the PPQA Review Report.

The PPQA reviewee:

- Schedule a meeting, if necessary.
- Discuss the findings and recommendations with the PPQA reviewer.
- Collect a detailed summary of findings and recommendations using the PPQA Review Report.

- Collect the metrics as outlined in the PPQA Review Report.

6.6.5.3 Perform Necessary Rework

After conducting the PPQA reviews, perform the necessary rework.

The PPQA reviewee:

- If in agreement, update the PPQA Review Report with the proposed resolutions and projected completion dates.
- If in disagreement, discuss item in question with the PPQA reviewer. If this issue is not resolved, escalate the issue to the project manager.
- Forward the PPQA Review Report to PPQA reviewer for closeout.

The PPQA reviewer:

- Contact the PPQA reviewee to discuss disagreements (if necessary). If a resolution cannot be reached with the PPQA reviewee, escalate the issue to the QPI liaison.
- Close out the PPQA report by entering the date accepted in the PPQA Review Report.
- Forward the PPQA Review Report back to the reviewee and QPI liaison.

6.6.5.4 Analyze Review Result

After performing necessary rework, analyse the results.

The project manager or metrics lead:

- Track the metrics, as outlined in the Project Measurement Plan.
- Report the PPQA activities during process PPQA/best practices reviews.

6.6.6 Quality Assurance (QA) Reviews

6.6.6.1 Milestones

Include any key project milestones in this section. Typically, a reference to the Project Plan and Work Plan for milestones is made. If including specific milestones in the Quality Management Plan, include a reference within the Plan and/or Process Dependencies section of this document made to ensure related documents align.

6.6.6.2 Measures

Include project measures in this section. Typically, a reference to the Project Measurement Plan is made. If specific measures are included in this Quality Management Plan, include a reference within the Plan and/or Process Dependencies section of this document to ensure related documents align.

6.7 Project Human Resource Management

This defines the processes for managing the human resources for the project. Human resources are required to deliver the projects successfully and managing men is major concerns on the organisations. This requires motivational skills, understanding training and retraining requirements, performance appraisals, building up teams and team environments. With distributed work environments managing resources becomes more complex and challenging due to risks like time zone management, cross cultural issues and communications. The objectives of team management are:

- Orient and train team members as they join the project and as they change roles within the project.
- Provide coaching and support so team members can perform effectively.
- Motivate and challenge team members and clarify the importance of their roles in the project.
- Manage integrated teams and ensure members are performing effectively as a team.
- Manage physical resources.

Benefits of work teams include the following:

- Faster turnaround time for delivering products or services
- Improved productivity and adaptability to changes
- Decreased sensitivity to volume fluctuations
- Reduced cost
- Greater employee involvement and ownership
- Higher employee morale
- Task variety
- Increased skill development

Steps to make an effective team are:

- Clarify the Team's Task and Function (Team Charter)
- Clarify Team Roles and Responsibilities
- Establish Operating Agreements
- Identify Critical Success Factors
- Develop an Action Plan
- Begin Collaborative Skills Development
- Establish Measures and Measuring Progress

The Project teams are to be built as per the requirements of the project, skills and experience needed and the availability of the resources. Projects also have to consider the cost of the resources to be hired for the assignment so that they don't go over the budget. The *ProjectTeamAcquisition* class is used to Develop and Acquire Team Members and also define the Performance criterion. Project Management Plan is updated to show the resources working on the project. Team performance objectives, Appraisals are attributes of *HRMPlan* class to the Appraisal Criterion. The Training needs matrix is developed and training programmes are developed according to the needs of the project and team members. The training programmes are conducted at appropriate schedule which matches project and resource calendars, which are part of Project Team Development class.

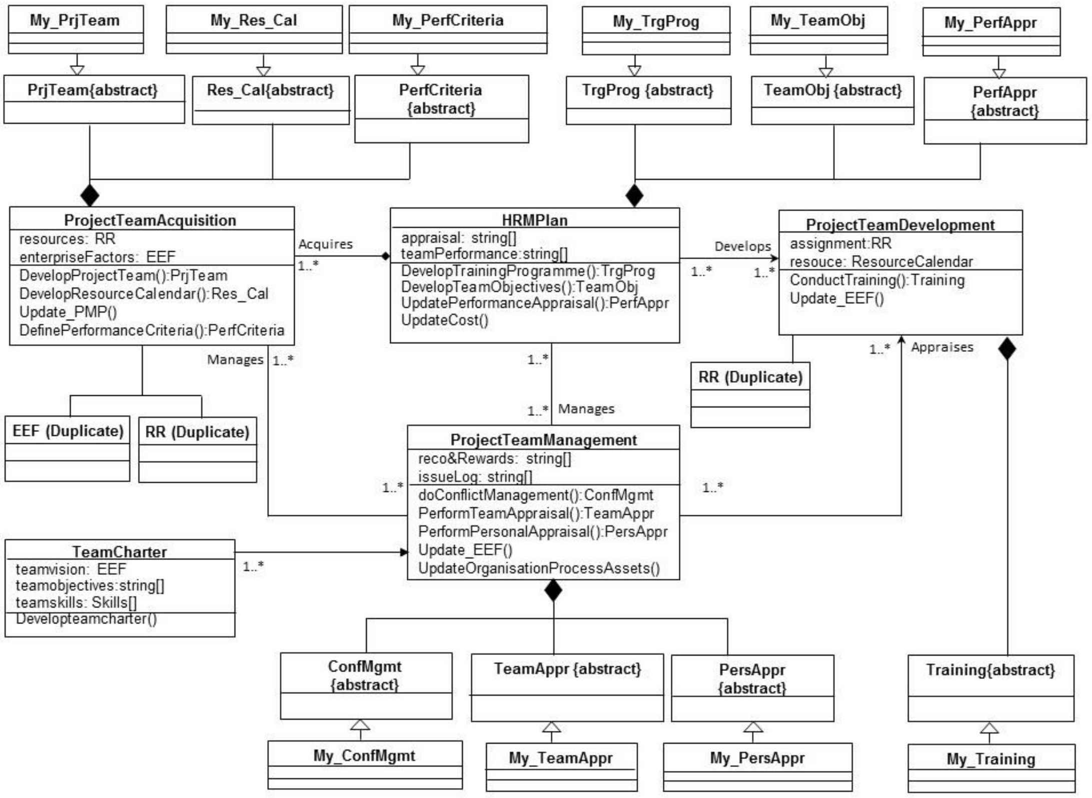


Figure 6.9 Project HR Management

The *ProjectTeamManagement* class has attributes of Recognition and Rewards and updates the issue log. Project Managers have to manage the conflicts, perform the appraisals, give recognition and rewards as per the overall team appraisals and performance. The Enterprise Environmental Factors and Organisation Process Assets are updated based on the information about the resources.

Table 6.13 Project HR Management

PMBOK[1] processes and activities (section)	**Formalised Model**
Plan Human Resource Management (9.1.1 - 9.1.3)	HRMPlan class Operations: DevelopTrainingProgramme() DevelopTeamObjectives() UpdatePerformanceAppraisal() UpdateCost()
Acquire Project Team (9.2.1 - 9.2.3)	ProjectTeamAcquisition class Operations: DevelopProjectTeam()

PMBOK[1] processes and activities (section)	**Formalised Model**
	DevelopResourceCalendar() Update_PMP() DefinePerformanceCriteria()
Develop Project Team (9.3.1 - 9.3.3)	ProjectTeam Development class Operations: ConductTraining() Update_EEF()
Manager Project Team (9.4.1 - 9.4.3)	Project Team Management Operations: doConflictManagement() PerformTeamAppraisal() Perform_PersonalAppraisal() Update_EEF() UpdateOrganisationProcessAssets()

6.7.1 Orient and Train Team Members

Plan the human resources and team for the project as per the activities Plan Human Resource Management (9.1.1 - 9.1.3) given in the Table 6.13.

- Gather roll-on and roll-off information for all new team members.
- Confirm team member's knowledge, skills, and functional expertise to perform the task.
- Confirm team composition, and mix of knowledge, skills, and functional expertise of individual team members, provide the necessary structure for the team to succeed.
- Confirm individual and team work assignment. Clearly define roles and responsibilities. They should include completion of project deliverables, individually, and as a team, as well as activities related to project management (e.g., status reporting, issue/risk management, requirements management, configuration management etc.).
- Confirm performance expectations on what should be accomplished for the project as well as individual expectations on career growth and development.
- Use the Training Needs Matrix to determine the appropriate orientation and training sessions for each new member of the team. Mark required training accordingly.
- Coordinate orientation and training schedule of team members. Identify the impact of the time required to attend training on the project timelines.
- Allocate time for participation in the required training courses
    - Leverage the appropriate recommended training courses.
    - Confirm that each member completed the mandatory courses appropriate for their role and level of responsibility.
- Track training schedule and completion in the Training Needs Matrix.

- Perform project orientation sessions.

6.7.2 Evaluate and Coach Team Members:

Evaluate and coach team, or team member, in a timely manner. When evaluating and coaching:

- Observe individual and team performance.
- Assess match between individual knowledge, skills, and experience, and current work assignment, responsibility, and authority.
- Monitor progress against team objectives, and identify individual and team skill gaps.
- Evaluate the effectiveness of team orientation and training from how they are reflected in individual and team performance.
- Give informal, constructive feedback frequently, and conduct formal progress reviews on a regular, timely basis.

At interval agreed during expectations setting, the project manager or the team lead should informally evaluate the performance of the individual team member against individual and team goals. This can be in form of training, counseling, re-assignment of responsibilities, enhancing the responsibilities etc. The goals of coaching should be both on individual growth and team development

6.7.3 DevelopProjectTeam():

6.7.3.1 Select and Organize the Team:

Select and organise the project team as per the activities Acquire Project Team (9.2.1 - 9.2.3) given in the Table 6.13.

- Obtain the authority to select team members, when possible.
- Recruit people who are good team players as well as technically competent.
- If someone wants to be released from the team or proves to be disruptive (even after counseling), help them to become reassigned elsewhere.
- Obtain input from the program manager.
- Do not accept (or keep) team members whose technical skills are inadequate, unless you can quickly eliminate the inadequacies through training or other means.
- Carefully plan, document, and communicate the project organization with regard to responsibility and authority.
- Keep the team organization as flat as possible: vertical organizations cause difficulties in achieving problem-solving participation and good communications.
- Plan for appropriate supervisory spans of control, considering experience and ability as well as the difficulty of their assigned responsibilities.
- Ensure that each member has a clear idea of working relationships with others, including communication, coordination responsibility, and authority.
- Ensure that everyone to whom you delegate supervisory responsibility is committed to helping you achieve your project team management goals.

6.7.3.2 Build Internal Team Communications and Team Spirit

- Encourage and conduct formal and informal meetings to:
    - Review status, new developments, successes, and failures.
    - Brainstorm alternatives, and evaluate them.
    - Discuss and resolve issues and problems, including team strengths and areas for improvement.
- Set an example by communicating openly.
- When possible, treat all problems as team problems, so everyone is responsible for helping to solve them.
- Arrange facilities so that the entire team is in close proximity, when possible.
- Ensure that a "war room," and rooms that facilitate small working groups, are available for use by the team.
- Encourage healthy competition, i.e., competition that fosters project objectives, and which challenges and motivates team members.
- Encourage team social interaction.
- Consistently demonstrate your enthusiasm for the project.
- Make sure that the formal and informal communication systems, including the program/project reporting system, flow through the team as well as upward and outward to external organizational entities.

6.7.3.3 Build Individual Team Member Commitment

- Deeply involve each member.
- Give each member some challenging, interesting work.
- Treat each member as a "customer" when you give a work assignment.
- Involve each member in group planning and problem-solving activities.
- Manage by walking around (MBWA).
- Give team members exposure in meetings.
- Give credit privately and publicly for excellent work.
- Watch for, and deal directly with, individual objectives that conflict with those of the project.
- Ensure that team members understand how their pieces fit in and contribute to the project objective(s).
- Delegate responsibility on the basis of the person's readiness to accept it.

6.7.4 ConductTraining():

Develop and conduct training for the team members as per the activities Develop Project Team (9.3.1 - 9.3.3) in the Table 6.13.

6.7.4.1 Training Readiness Checklist

Use this to determine whether the training materials have been completed, sufficiently tested and piloted, and are ready to be implemented.

Requirements

- Generate requirements based on direct input from target audiences.
- Prioritize requirements based on criticality of the training needs.
- Fully address requirements in the training plan and training materials.

6.7.4.2 Training Sponsor

- Ensure the project sponsor has signed off on the scope of the training.
- Fully address sponsor goals and expectations on training.
- Fully address sponsor concerns on training.
- Secure sponsors who promote training implementation at the deployment sites.
- Ensure the training sponsor has signed off on the training plan and the training materials.

6.7.4.3 Training Plan

- Ensure the Training Plan contains information on target audience and number of people in each audience group, training objective, instructional strategy, delivery strategy, modules, length per module, prerequisites, training dates and locations, technical requirements, logistical requirements, and evaluation approach.
- Create the Training Plan based on pilot and roll-out schedules of the application.
- Consider the availability of training participants around the target dates.
- Consider the technical infrastructure constraints at the training locations.
- Include the plan for production simulation.

6.7.4.4 Training Materials

- Create training materials using the appropriate standards and templates.
- Ensure training materials follow the appropriate branding requirements.
- Correct training materials for typing and grammatical errors.
- Finalize training materials by checking for content appropriateness and message effectiveness.
- Test and pilot training materials.
- Revise training materials based on feedback from the pilot.
- Customize training materials as needed to fit the needs of the specific deployment group.

6.7.4.5 Training Database

- Secure the person supporting the training database.
- Ensure the training database contains the right training data.

- Communicate the process to refresh and maintain training database.
- Update the training database with the latest version of the application.

Training Launch

- Secure and set up training sites.
- Set up, test, and ensure the technical infrastructure required to run the training is working properly.
- Set up, test, and ensure training equipment is working properly.
- Package training materials for deployment.
- Secure instructors, coaches, and support personnel who run the training.
- Sufficiently prepare instructors, coaches, support personnel, and ensure they are ready to run the sessions.
- Track, communicate, and process issues arising throughout the training effort.

6.7.4.6 Training Participants

- Identify the training audience according to the scope of the training.
- Ensure the training team has analyzed the audience profile.
- Ensure the training sponsor has approved the audience list.
- Communicate the training objective, in the context of the project, to all participants.
- Ensure the training participants have received the necessary information about the training.
- Ensure the training participants have responded to the training invitation.
- Ensure the training participants have completed the necessary prerequisites, if any, for the upcoming training modules.
- Make sure the training participants have clear expectations of what the training is all about.
- Ensure all participating parties have indicated/confirmed functional and technical readiness to actually participate in the training sessions.
- Distribute a detailed training schedule including dates, times, objective, agenda, participation instructions, etc. to all training participants.

6.7.4.7 Training Evaluation

- Clearly define the objective of training evaluation.
- Define the metrics for evaluating training effectiveness, and set the target.
- Document and agree on the process for collecting feedback on the effectiveness of the training effort.
- Create the evaluation form, and define the process for tabulating results.

6.7.5 doConflictManagement()

6.7.5.1 Resolve Anxieties to Increase Satisfaction and Productivity

Manage the project teams and conflicts corresponding to the activities Manager Project Team (9.4.1 - 9.4.3) given in the Table 6.13.

- Recognize that every project assignment is a new experience, which may be a source of some anxiety.
- Ensure that team members clearly understand:
    - Their responsibility, accountability, and authority
    - How their performance is evaluated
    - The professional development that they achieve from the assignment
    - Any personnel and administrative matters affecting them that arise as a result of the assignment
- Establish standards and procedures to provide consistent guidelines that reduce ambiguity.
- Provide frequent feedback on performance.
- Do not apply negative pressure to meet budget and/or time targets; beyond a certain point, this is counterproductive.
- Deal with team members supportively, not in a threatening manner.

6.7.5.2 Achieve and Encourage Group Creativity in Problem-solving

- Use group problem-solving techniques, such as brainstorming, to avoid excessive reliability on individual experts.
- Resolve to get things completed through the cooperation of others rather than through your formal authority.
- Be open to new ideas; avoid the "Not Invented Here" (NIH) syndrome.
- Never characterize ideas as "bad" (or allow others to do so).
- Ensure that formal meetings are well planned and held only for identified purposes.
- Let team members participate in planning how they accomplish their work assignments.

6.7.5.3 Establish your Competence, Credibility, and Authority

- Be honest and candid.
- Do not play favourites.
- Listen to team members, especially when they know more than you do.
- Use your authority of position when leadership is needed.
- Ensure that the program manager issues notice to organizations to establish your authority and responsibility.
- Use your position at the hub of the project information system to foster communication and commitment.
- Prepare formal performance evaluations for all team members.

6.7.5.4 Avoid and Resolve Conflicts

- Avoid conflicts by:
    - Carefully organizing the team so that relationships are clear
    - Carefully assigning the work effort so that responsibilities are clear
    - Keeping everyone informed
- Recognize that team members' performance is a function of the organization's sociotechnical environment and team members' abilities and motivation.
- Resolve conflicts through use of techniques such as:
    - Problem-Solving. Treat the conflict as a problem to be solved by examining alternatives.
    - Win-Win Negotiating. Search for solutions that allow all parties some sense of satisfaction.
    - Withdrawing or Smoothing Over. Use this technique to temporarily defuse a situation. Follow up with another technique to resolve the conflict.
    - Forcing. Use your authority, or a higher authority, to decide the issue. This is only appropriate as a last resort after all other efforts have failed.
- Accept that conflicts are inevitable, and try to resolve them on the basis of the logic of the situation.
- Minimize potential conflicts over performance by ensuring that team member training needs are identified and resolved.
- Depersonalize conflicts whenever possible; deal with them as logical issues as opposed to personality problems.
- To help avoid or mitigate internal team conflict, invite supportive external organizational entities to serve as guest speakers at team meetings. This provides outside evidence of the project's importance and management's view of its high priority relative to other possible team member interests and responsibilities.

6.8 Project Risk Management

This describes the processes for managing, prioritising, and mitigating risk for the project. This risk management plan includes risk management planning identification, analysis, response planning, monitoring & Control. The purpose of risk management is to increase the probability and impact of positive events and decrease the probability and impact of negative events on the project. Risk could be defined as something or event which may or may not happen. Risk Management recognizes, assesses, and controls the uncertainties that may result in schedule delays, cost overruns, performance problems, adverse environmental effects, or other undesired consequences. Identify and analyze risks to determine their relative importance and mitigate them to reduce adverse impacts.

Projects analyse, monitor, and mitigate the risks identified in project planning. Use a Risk Management Plan and risk tracking tool to carry out risk management activities.
Positive events/ impacts or good risks are called Opportunities and Negative events/ impacts are called Threats. Uncertainty is lack of knowledge about an event that reduces confidence in conclusion drawn from the data. It is seen that around 90% of the threats can be eliminated if they are thoroughly identified and investigated [1].

Project Risks is an uncertain event or condition that, if it occurs, has a positive or negative impact on at least one of the project objectives such as time, cost, scope, or quality.

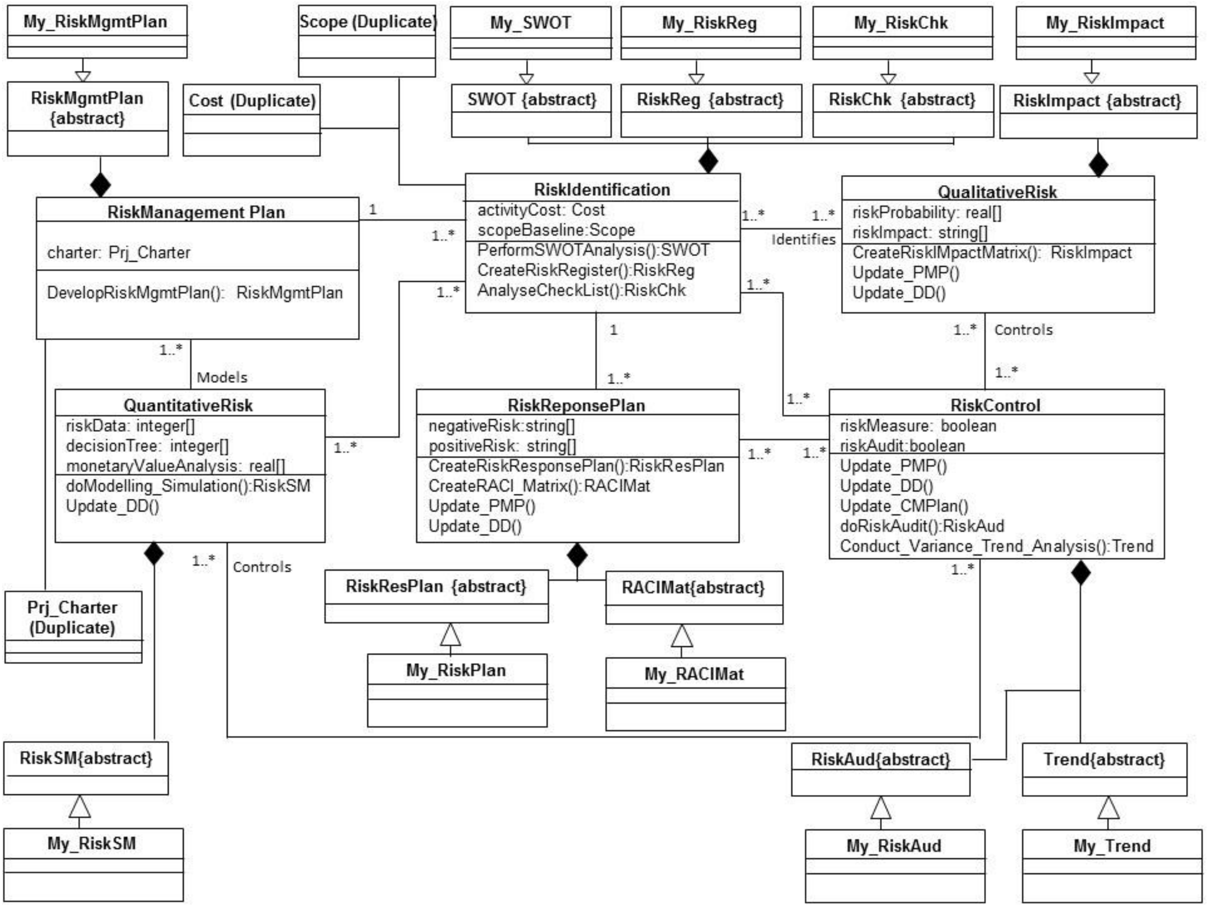


Figure 6.10 Project Risk Management

When investigating a risk, one should determine: The probability that it will occur; the range of possible outcomes, expected timing in the project life cycle, anticipated frequency or risk events from that source. Risk Identification ensures that we do the SWOT analysis and create Risk register and checklists for better monitoring and control. Risk tolerances and thresholds are identified which are unacceptable and acceptable for a particular project. Risks are analysed for qualitative and quantitative impact on the projects.

Risk response strategies for threats are Avoid, Mitigation, Transfer (Deflect/ allocate) which are part of *Risk Response Plan* class. Response strategies for Opportunities are Exploit and Enhance. For the remaining or residual risks prepare a contingency plans and in case contingency plans are not effective then use fall-back plans. RACI (Responsible, Accountable, Consulted, Informed) Matrix or RASCI (where S is for supported) matrix are created to identify people who are stakeholders for monitoring and controlling the risks.

Risks should be monitored and controlled in an efficient manner for successful delivery of good quality projects. Risk audits are done at regular intervals and various plans such as Project Management Plan, Configuration Management plan, and Deliverable Documents are updated/ modified to reflect the changes and action taken.

Table 6.14 Project Risk Management mapping

PMBOK[1] processes and activities (section)	**Formalised Model**
Plan Risk Management (11.1.3)	RiskManagementPlan class DevelopRiskMgmtPlan() operation
Identify Risks (11.2.3)	RiskIdentification class Operations: PerformSWOTAnalysis() operation CreateRiskRegister() operation AnalyseCheckList() operation
Perform Qualitative Risk Analysis (11.3.1 – 11.3.3)	QualitativeRisk class CreateRiskImpactMatrix() operation Update_PMP() operation Update_DD() operation
Perform Quantitative Risk Analysis (11.4.1 – 11.4.3)	QuantitativeRisk class doModelling_Simulation() operation Update_DD() operation
Plan Risk Responses (11.5.1 – 11.5.3)	RiskResponsePlan class CreateRiskResponsePlan() operation CreateRACI_Matrix() operation Update_PMP() operation Update_DD() operation

PMBOK[1] processes and activities (section)	**Formalised Model**
Control Risks (11.6.1 – 11.6.3)	RiskControl class Update_PMP() operation Update_DD() operation Update_CMPlan ()operation doRiskAudit() operation Conduct_Variance_Trend_Analysis() operation

6.8.1 Risk Approach

During this step, the project determines how it turns risk information into decisions and actions. Determining the approach to identified risks involves developing actions to address individual risks, prioritizing risk actions, and creating an integrated risk action plan as described in the activities Plan Risk Management (11.1.3) given in the Table 6.14.

The following process is recommended for determining the project approach for identified risks:

- Develop risk scenarios for high-severity risks.
- Develop risk mitigation alternatives.
- Select the risk mitigation approach.
- Develop a risk action plan.
- Establish thresholds for early warning.

Indicate the specific processes for determining an approach to a risk in your project's Risk Management Plan.

6.8.2 Develop a Risk Action Plan

This process details the selected approach to risk mitigation. The risk action plan for each identified risk is documented in the project's Risk Log and includes the following elements:

- Contingency plan
- Mitigation plan
- Mitigation steps/action taken
- Owner

The risk action plan captures the risk's resolution strategy in a standard format. All of the project's risks and associated action plans are in the Risk Log.

The following risk action plan information is tracked within the Risk Log:

- Impact. This is the risk's magnitude if it occurs. This number could be the dollar value of the loss or simply a number between one and ten that indicates relative magnitude.

- Exposure. This is the risk's overall threat to the project, balancing the likelihood of actual loss with the magnitude of the potential loss. The team uses risk exposure to rate and rank risks.
- Description. This is the condition that exists that could possibly lead to a loss for the project and a description of the loss that would occur if the risk were to become certain.
- Due dates. This is the date when the team completes each planned action item.
- Personnel Assignments (Owner). These people are assigned to perform the action items.
- Functional Area. This is the team impacted by this risk.
- Category. This is the category affected by this risk (e.g., Development stage).
- Risk Area. This is the type of risk.
- Control. This indicates if the risk is internal or external to organization.
- Contingency Plan. This describes the team strategy in the event that the actions planned to manage the risk fail. The team would execute the risk contingency strategy if the trigger were reached.
- Risk Mitigation Description. This is the process by which risks mitigation alternatives are selected by selection criteria to mitigate/resolve a risk.
- Risk Mitigation Steps. These are the steps taken to implement a mitigation of risks, such as itemize resources necessary to perform risk mitigation, for example, the number of resources required.

6.8.3 Establish Thresholds for Early Warning

Early in the project, risk assessments tend to identify risks that are not critical. Even though these risks are not critical at the moment and the time frame is not immediate, monitor these risks in case they become critical. Risks that may affect the project need quantitative targets and thresholds identified. Targets are quantitative goals, and thresholds are minimum performance value and indicate when the risk is in danger of becoming an issue. Therefore, thresholds indicate a need for action.

6.8.4 Risk Monitoring

Risk tracking is the fourth step in the risk management process. In it, the team monitors the status of risks and the actions it has taken to mitigate them. Risk tracking is essential to effective action plan implementation. This means devising the risk metrics and triggering events needed to ensure the planned risk actions work. Complete this through reporting. Document risks in a tool such as a spreadsheet, MS Access database supplied by QPI, and/or other possible tools.

The following risk tracking process is recommended:

- Monitor risk scenarios.
- Compare the thresholds to status.

- Provide notification for triggers.
- Report risk measures and metrics.

Indicate the specific processes for tracking risks in your project's Risk Management Plan.

6.8.5 Monitor Risk Scenarios

Risk scenarios are monitored to determine if the probability of risk occurrence is changing. Tracking risk scenarios over time increases the level of confidence that risk probability was accurately projected.

6.8.6 Compare Thresholds to Status

Status reports and other project documentation monitor the thresholds outlined during Determine Approach to Identified Risks. Once a threshold is exceeded, execute the risk action plan.

Provide Notification for Triggers

Triggers are set to notify the project when unacceptable risks are encountered. Triggers can indicate the need to revisit the risk action plan, inform the project that the risk action plan can be put on hold, or signal the release of an action plan.

- Periodic event. This is a notification for project-scheduled activities. Project scheduled events such as monthly management reports, project reviews, and technical design reviews are the basis for periodic event triggers.
- Elapsed time. This is a notification for dates based on a calendar. A calendar is the basis for elapsed-time triggers (e.g., thirty days from today, end of quarter).
- Relative variance. This is a notification outside a range of acceptable values. A deviation of a specified value either above or below a planned value target sets a trigger to raise a flag. Relative variance is useful to monitor a risk when a change occurs.
- Threshold value. This is a notification for values that cross a predetermined threshold. A comparison of a status indicator to threshold value is the basis for threshold value triggers. A trigger is set when a status indicator crosses a threshold value. For example, a project has a budget of $100,000. A cost indicator of $80,000 triggers the project manager to report the results within the fixed-cost budget.

6.8.7 Risk Mitigation

Risk mitigation is the last step in the risk management process. Risk mitigation defines the activities and methods used to reduce risk to an acceptable level.

After the team chooses the risk metrics and the triggering events, there is nothing unique about risk management. Rather, risk management melds into project management processes to control the risk action plans, correct for variations from the plans, respond to triggering events, and improve the risk management process.

Resolving risks consists of risk mitigation techniques and corrective action procedures. The following risk mitigation process is recommended:

- Respond to the notification of trigger event.
- Execute the risk action plan.
- Report progress against the plan.
- Correct for deviation from the plan.

Indicate the specific processes for mitigating risks in your project's Risk Management Plan.

6.8.7.1 Respond to Notification of Triggering Event

Triggers provide notification to appropriate personnel. Triggers provide a reasonable time for response and should not constitute a crisis situation. An appropriate response includes a review of the current reality and an updated determination of the time frame for action.

6.8.7.2 Execute the Risk Action Plan

Follow the risk action plan to mitigate risk. If the plan is not documented, chances are there is a miscommunication already. Map the objectives of the risk action plan to specific actions that you will take to reduce uncertainty and increase control.

6.8.7.3 Report Progress Against the Plan

Determine and communicate progress made against the Risk Management Plan. Report the risk status on a regular basis to improve communication within the team. Simply reporting risk status is not sufficient to manage risk. The team must review the risk status, measures, and metrics regularly to provide for risk aware decision making.

6.8.7.4 Correct for Deviation from the Plan

Sometimes results are not satisfactory and another approach should be used. Take correct action when necessary.

6.8.7.5 Risk Resolution Techniques

Implementing the risk action plan may require generating new and innovative ideas, making creativity key in resolving a risk. There are four innovation styles that assist with the creative process:

- Envision. This focuses on the end result. It provides team with direction, inspiration, and momentum. One can imagine an ideal result and then let the goals guide their vision.
- Experimenting. This uses the trial and error method. It emphasizes fact finding and information gathering, and then emphasizes testing new combinations of ideas.
- Exploring. This provides a team with the potential for dramatic breakthroughs by approaching problems from new angles.

- Modifying. This is a step-by-step process where the project builds on what is true and proved by applying known methods and using experience. It provides a team with stability and incremental improvements.

6.8.7.6 Preparing for Risk Management

- Identify key potential risk areas corresponding to the activities Identify Risks (11.2.3) given in the Table 6.14.
- Formulate risk mitigation strategies at the same time.
- Ensure that these strategies are followed and that they successfully address the project risk areas.
- Plan to routinely re-evaluate the status of the project against the risk criteria to check for additional risk areas.

Strategic

- Review delivery requirements and responsibilities to ensure that they are clearly defined, including service level agreements (SLAs), Business Case, and acceptance process.
- Determine third party dependencies, and document the responsibilities and accountabilities.
- Review financial considerations to ensure all are documented, including payment terms, cost estimate, contingency costs, as well as currency rate considerations.
- Review legal considerations to ensure all are documented including intellectual property rights, warranty period, and liability.
- Determine any hazardous environment issues including regulatory changes, political instability, natural disasters, or security issues. Ensure contingency plans are in place and documented.
- Review miscellaneous issues including criticality to client, environmental considerations, global development/maintenance, start-up company, or large/complex projects.

Operational

- Ensure delivery information is documented and the client team is made aware, including: Business Case, contractual obligations, client requirements, client responsibilities, Service Level Agreements, and contractor involvement.
- Ensure metrics are in place and documented and that client team are made aware, including: change control procedures, acceptance procedures, and monitoring to Business Case.
- Identify core activities and business functions along with the individuals critical to success of those activities and functions.
- Ensure client sponsorship, client business, and client industry are stable and plans are in place to review periodically.

- Ensure formal and informal meetings are planned and completed, to confirm client expectations are being met.

Financial

- Properly estimate the cost of resources including staffing, training, technology, third party costs, and external costs such as currency and inflation.
- Validate areas of potential cost overruns and plan to track those costs more closely.
- Document plans for tracking costs related to work occurring in a region vulnerable to hyperinflation.
- Confirm arrangements for transferring external financial risks such as currency and inflation rate risk.

Hazard

- Develop contingency plans to address potential natural disasters (i.e., earthquakes, hurricanes, floods, or fires) or political risks.
- Develop contingency plans to address workplace safety issues in environments including but not limited to: Distribution Centers, Manufacturing Plants, High Profile Buildings, Hazardous Chemical Exposures, and Adjacent to Government Offices or Buildings.
- Verify there are procedures in place to safeguard project and client data.

6.8.7.7 Risk Identification:

6.8.7.7.1 Risk Identification Sources

The risk management process is an iterative cycle that is performed initially during project risk identification and monitored continually throughout the project life cycle. Usually project management and other project experts perform risk identification. However, any project team member can identify risks. Risks may arise from a variety of sources, including the following:

- Status meetings
- New risks previously missed or unforeseen requirements
- Review project documents
- Group interview sessions
- Project-developed risk identification checklists\questions
- An approved change request that implies the critical path including cost, schedule, and scope
- Major issues escalated from the team/project levels
- Current risks whose response requires investigation
- The outcome or consequence of a separate risk occurrence identified
- Project thresholds exceeded, especially the metrics threshold

Typically, the production of a baseline of the areas where initial risks are likely to be identified is useful for developing and refining the risk and its response further.

6.8.7.8 Common Project Risks

Ask a variety of questions during risk meetings, and review them during subsequent risk management discussions to form a list of potential risks. Review these risks to help identify possible risks the project faces.

6.8.7.9 Documentation of Risks

After risks are identified by the project, begin documenting the risks. The risks identified are documented into specifically defined, tangible risk items, for which a response/action may be well defined and measurable. This ensures all analyses and reporting of risks maintain a deliverable-focus so progress towards high-level objectives can be compared. Examples of tools used to document risks include spreadsheets, risk logs.

6.8.7.10 Risk Analysis

Risk analysis forms the second step in the risk management process. It is primarily concerned with developing specific, discrete, and measurable responses to each risk and developing a list of prioritized risks corresponding to the Perform Qualitative Risk Analysis (11.3.1 – 11.3.3) activities given in the Table 6.14.

This is not necessarily limited to the development of only one response per risk; two or more alternative responses may be defined if the response to that risk is contingent on the outcome of a prior event. Additionally, the combination of two or more interdependent risks is evaluated. The following risk analysis process is recommended:

- Group similar and related risks.
- Analyze the risk using risk analysis.
- Quantify the risk.
- Rank the risks relative to other risks.

Indicate the specific processes for analyzing risks in your project's Project Measurement Plan.

6.8.7.11 Group Similar and Related Risks

Group similar risks according to category based on the severity or probability such as low, medium or high. For example, lack of funding for the project is a high risk that can be grouped in financial category of risks. Cease any redundant risks. Combine related risks when it makes sense to work the risks together. Link dependent risks when the outcome of one requires consideration when prioritizing the other.

6.8.7.12 Analyze the Risk Using Risk Analysis

After grouping the risks, use risk analysis techniques and tools to further structure, analyse, and evaluate the project's risk. Risk analysis techniques deal with conflicting cost and performance goals, uncertainty, and risk preference.

6.8.7.13 Risk Analysis Techniques

The following are techniques used to analyse risks.

6.8.7.13.1 Causal Analysis

Causal analysis shows the relation between an effect and its possible causes to examine the risk's root cause. It prevents problems by determining the problem's source. Follow the three-step process to perform causal analysis:

- Determine the error's cause.
- Determine the actions that will prevent the error in the future.
- Implement these corrective actions.

6.8.7.13.2 Decision Analysis

Decision analysis structures the decisions and represents problems by models that can be analysed to gain understanding. The decision model's elements are the decision, uncertain events, and values of outcomes. There are two techniques for performing decision analysis: the influence diagram and the decision tree.

Figure 6.11 shows an influence diagram. An influence diagram provides a graphical representation of the elements of a decision model. A common notation is used:

- Squares represent decision nodes.
- Circles represent chance events.
- Rectangles with rounded corners represent values.
- Double circles represent outcomes known when the inputs are given.

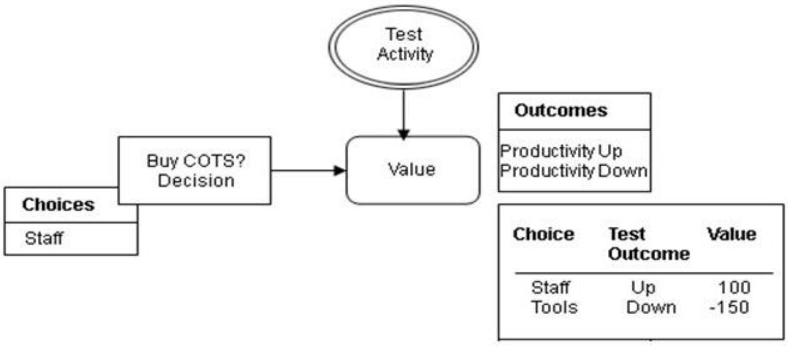


Figure 6.11 Influence Diagram

The major components of a decision model are represented in this influence diagram: the decision to buy commercial off-the-shelf (COTS), the chance test activity outcome, and the value of the possible outcomes.

Figure 6.12 shows a decision tree. A decision tree provides a graphical representation of the elements of a decision model. A common notation used is:

- Squares represent decisions.
- Branches emanating from a square represent choices.
- Circles represent chance events.

- Branches emanating from a circle represent possible outcomes.
- The ends of the branches specify values of outcomes.

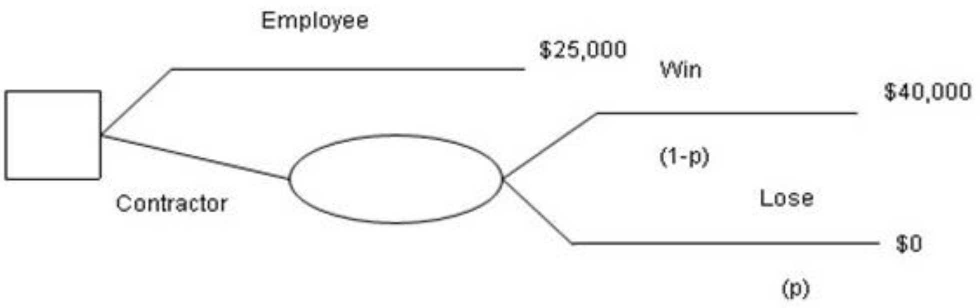


Figure 6.12 Decision Tree

The decision tree models one decision (the square) and one uncertain event (the circle). The decision to work as an employee for a guaranteed $25,000 or as a contractor for $40,000 depends on the probability (1-p) of winning a competitive bid. Given that the probability is unknown, you could predict the decision if their risk preference was known.

6.8.7.13.3 Gap Analysis

Gap analysis is the difference between two variables. Gap analysis determines the need for improvement. This also includes the As-Is and the To-Be models. The As-Is is the project's current stage, whereas the To-Be shows the project's future stage. Corrective action is based on the identified gaps.

6.8.7.13.4 Pareto Analysis

Pareto analysis determines the order to address the issues. The basis of Pareto analysis is the 80/20 rule where 20 percent of the sources cause 80 percent of the problems. This analysis focuses on the risks that have the greatest potential for reducing problems. A Pareto chart shows the distribution of identified risks (frequency) or risk exposure (cost).

6.8.7.13.5 Sensitivity Analysis

Sensitivity analysis helps determine the model's sensitivity to variations in input variables by setting each variable to its extreme points. Variables with the ability to affect the decision are important; the others are relatively less important. This analysis helps prioritize data collection and focus on variables with the greatest significance.

6.8.7.14 Quantify Risk

During this step, risks are quantified according to the project's chosen method of assigning a value to risk as described in the activities Perform Quantitative Risk Analysis (11.4.1 – 11.4.3) in the Table 6.14. Several methods exist for quantifying risk including the risk assessment matrix, risk dispersion charting, and risk severity.

Risk quantification extends the value of the analyzing, understanding, documenting, and reporting on project-level risks by attempting to assign each risk to a numerical scale. Risk is composed of two factors: probability of risk occurrence and severity of impact. Other methods used to quantify risk include consequence and time frame.

Risk probability is the likelihood that an event will actually occur. Using a numerical value for risk probability is desirable for ranking risks. Risk probability must be greater than zero but less than 100 percent, or the risk is a certainty. Impact measures the effect that the risk will have on the project.

These measures assist in realizing and focusing on the true impact of each risk and in prioritizing the risk-reducing activities and responses identified.

6.8.7.15 Probability

The likelihood of risk occurrence can be evaluated qualitatively or quantitatively. The table below shows a scale for rating probability:

Table 6.15 Probability

Probability	% Value	Uncertainty statement
> 80%	90%	Highly likely, Almost certain
61%-80%	70%	Probable, Likely
41%-60%	50%	Improbable
21%-40%	30%	Unlikely
1%-20%	10%	Highly unlikely

6.8.7.16 Impact

Impact is an estimate of the overall scale of the impact following an occurrence of each risk. This measures the severity of adverse affects, or the magnitude of a loss, if the risk comes to pass.

This is rated on the following scale:

5 - This has a very high impact that threatens project’s success.

4 - This has a high impact that significantly disrupts successful delivery of the project’s objectives, products, and benefits.

3 - This has a medium impact that significantly disrupts the project’s schedule, cost, and products over the medium and long terms.

2 - This has a low impact that disrupts progress with moderate extensions to the schedule and cost across short and medium terms

1 - This has a very low impact with slight exposure.

6.8.7.17 Consequence

Consequence is the impact of a risk occurrence tailored to a specific project. Tailor the effect of a risk occurrence to a specific project. Project goals can help refine the evaluation criteria.

The table 6.16 below shows sample consequence criteria for cost, schedule, and technical goals. The table is only an example, so have projects establish their own criteria tailored to their size/cost/schedule.

Table 6.16 Consequence Criteria

Criterion	Cost	Schedule	Technical
Low	Less than 1%	Slip 1 week	Slight effect on performance
Moderate	Less than 5%	Slip 2 weeks	Moderate effect on performance
High	Less than 10%	Slip 1 month	Severe effect on performance
Critical	10% or more	Slip over 1 month	Mission cannot be accomplished

6.8.7.18 Time Frame

Project goals can help to refine the evaluation criteria. Tailor the time frame for action to prevent risk occurrence to a specific project. The time frame for action can be short, medium, or long. Tailor the time frame for action to prevent risk occurrence to a specific project. As shown in the table 6.17 below, the time frame for action can be short, medium, or long.

Table 6.17 Time Frame

Evaluation	Time Frame
1 month	Short
2 months	Medium
3 months	Long

There are several methods to graphically display the probability and impact of risk: a risk assessment matrix, risk dispersion charting, and risk exposure.

6.8.7.19 Risk Assessment Matrix

The risk assessment matrix considers both probability and impact. The impact of risk is plotted against probability, as displayed in Figure 6.13.

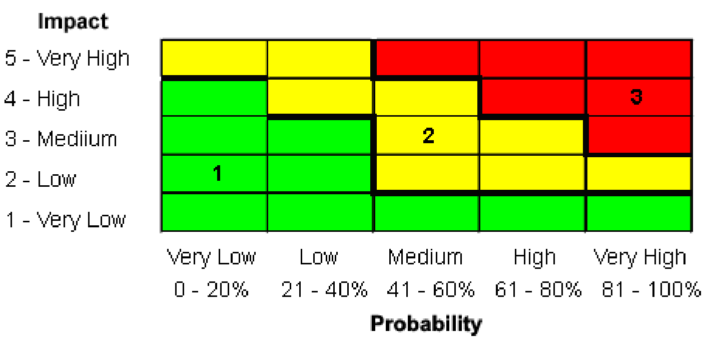


Figure 6.13 Risk Assessment Matrix

Risks that fall into area 1 (green) are Low and need monitoring. Risks that fall into area 2 (yellow) are Medium and need a mitigation plan prepared for implementation in case the risk increases in probability or impact. Risks that fall into area 3 (red) are High and require active steps to prevent them.

6.8.7.20 Risk Dispersion Charting

Another method for quantifying risk is risk dispersion charting. Compared to a risk assessment matrix, risk dispersion charting gives a detailed description of risks and the probability and impact of risk. In risk dispersion charting, each risk is mapped on a grid by its probability and impact, similar to a risk assessment matrix, allowing those risks with a high probability and high impact on the project to be visually identical and addressed. One part of risk evaluation is risk dispersion. Risk dispersion breaks risks into the following categories:

- Very High Risks. These goals cannot be accomplished.
- High Risks. These critical situations severely affect the goal.
- Medium Risks. These moderately affect the goal.
- Low Risks. These have a minor effect on goal.
- Very Low Risks. These have a slight effect on goal.

Figure 6.14 provides a detailed description of each risk ID. The risks are assigned ID numbers and grouped from high to low, and then charted graphically. For example, risk ID number 52 falls in Very High-Risk Area.

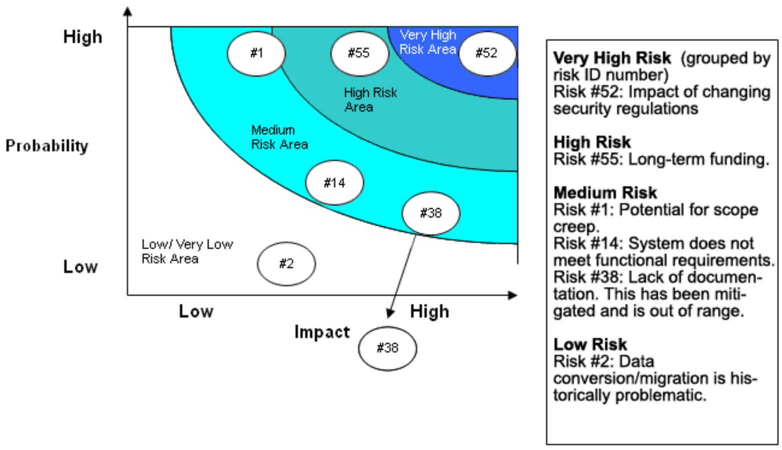


Figure 6.14 Risk Dispersion Charting

6.8.7.21 Risk Exposure

To calculate risk exposure, multiply the probability and impact if the risk occurred. Quantifying risks by the risk exposure provides a priority to the identified risks.

Risk Exposure (RE) = P X I

Risk exposure is the product of the primary risk attributes of likelihood and loss. Likelihood P is the probability of an unsatisfactory outcome. Loss I is the impact if an unsatisfactory outcome occurs.

Risk exposure and the time frame for action determine the relative risk severity. Risk severity helps to distinguish the current risk priority. Over time, risk severity changes to provide focus for the issues currently facing the project. See the table below as an example of a project's risk severity scale based on risk exposure.

Table 6.18 Risk Exposure and Severity

Risk Exposure / Time Frame	Low	Medium	High
Short	5	2	1
Medium	7	4	3
Long	9	8	8

6.8.7.22 Rank Risks Relative to Other Risks

Based on risk quantification, sort risks according to their importance. First address those with the highest risk exposure (probability X impact). By ranking the risks, project resources focus more efficiently and effectively.

6.8.8 Develop Risk Scenarios for High-severity Risks

A risk scenario is the projection of events and conditions that can lead to risk occurrence as per the activities Plan Risk Responses (11.5.1 – 11.5.3) given in the Table 6.14. Risk scenarios are developed for all risks that are critical to project success. Risk scenarios are developed in three steps:

- Think about the risk as if it had occurred.
- State the risk scenario as if the risk already happened.
- List the events and conditions that would precede the risk occurrence.

6.8.8.1 Develop Risk Mitigation Alternatives

Risk mitigation alternatives are the set of options that may mitigate/resolve risk if implemented. A project's risk mitigation strategy is preventative in nature and designed to reduce impact or probability of risk occurrence. A risk mitigation strategy uses acceptance, avoidance, protection, reduction, research, reserves, and transfer to develop alternatives for risk resolution. Each strategy contains objectives, constraints, and alternatives.

The project's risk mitigation strategy is documented during the Develop a Risk Action Plan step. A Contingency Plan is documented during the Develop a Risk Action Plan step as well. The Contingency Plan is executed if a risk is realized despite the implementation of the risk mitigation/resolution strategy.

Overall, a risk mitigation strategy covers five characteristic responses for risk mitigation:

6.8.8.2 Acceptance

This describes the factors that may directly affect the project's success but are outside the sphere of project management's influence and can therefore only be accepted. In addition, risk acceptance as a response may be based on the cost ineffectiveness of any available response or solution. For example, acceptance response could be created from a legislative or legal risk, over which no control could be leveraged.

6.8.8.3 Avoidance

Avoidance-based responses are employed at any point in the development life cycle where future-planning work is performed. Typically, most risk avoidance occurs during the project definition and planning stages of a project, where objectives, scope, key success factors, work breakdown, and project outputs or deliverables are defined. An example of risk avoidance is the use of a stable, established technical solution in preference to an untried or complex new technology. However, risk avoidance solutions may limit the ability to achieve high-level project objectives by unnecessarily constraining a desirable solution.

6.8.8.4 Control

Control-based responses occur at all points throughout the development life cycle and are typically the most common response. They identify an action or product that becomes part of the cell or area working plans and which are monitored and reported as part of the regular performance analysis and progress reporting of the project.

6.8.8.5 Transfer

Transfer-based responses target the party who is best placed to analyse and implement the response to the risk, based on their expertise, experience, and suitability. Typical transfer responses include the sub-contracting to specialist suppliers who can reduce the overall risk exposure.

6.8.8.6 Investigation

Investigation-based responses do not define any mitigation for reducing an individual risk. They are responses to risks where no clear solution is identified and further research is required. However, investigative responses should not be ignored, as they immediately and directly lead to a greater aggregated project risk. This is because the probability for each risk includes the effect of the applied response, for which there is none, and the level of control indicates the level of influence to apply that response, which is low.

6.8.8.7 Select the Risk Mitigation Approach

The risk mitigation approach narrows the set of options to focus on the best alternative to mitigate/resolve risk. Several risk mitigation strategies may be combined into one approach. Selection criteria determine the best alternative to resolve a risk.

Selection criteria provide a common basis to comprehend the characteristics of a good alternative. This is part of the risk resolution technique that helps determine the best alternative to resolve a risk. Selection criteria use two procedures---risk leverage and risk diversification.

6.8.8.8 Risk Diversification

Diversification reduces risk by distribution. It builds a balanced approach that stresses mastery of a project. Diversification deals with having multiple options rather than relying solely on one source. For example, projects should not rely heavily on one customer, vendor, method, tool, or person to fulfil project needs.

This process details the selected approach to risk mitigation. The risk action plan for each identified risk is documented in the project's Risk Log and includes the following elements:

- Contingency plan
- Mitigation plan
- Mitigation steps/action taken
- Owner

The risk action plan captures the risk's resolution strategy in a standard format. All of the project's risks and associated action plans are in the Risk Log.

The following risk action plan information is tracked within the Risk Log:

- Impact. This is the risk's magnitude if it occurs. This number could be the dollar value of the loss or simply a number between one and ten that indicates relative magnitude.
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- Due dates. This is the date when the team completes each planned action item.
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- Risk Area. This is the type of risk.
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6.8.8.9 Establish Thresholds for Early Warning

Early in the project, risk assessments tend to identify risks that are not critical corresponding to the activities Control Risks (11.6.1 – 11.6.3) given in the Table 6.14. Even though these risks are not critical at the moment and the time frame is not immediate, monitor these risks in case they become critical. Risks that may affect the project need quantitative targets and thresholds identified. Targets are quantitative goals, and thresholds are minimum performance value and indicate when the risk is in danger of becoming an issue. Therefore, thresholds indicate a need for action.

6.8.8.10 Report Risk Measures and Metrics

Measures and metrics determine the effectiveness of the risk management process. The project reports on risk measures and metrics to verify that risk management and tracking are occurring according to plan.

The project uses measures and metrics to determine risk management effectiveness.

- Number of risks. This is the count of risks currently being managed.
- Number of logged risks. This is the total account of identified issues logged in the risk database.
- Risk category. This is a count of the number of risks identified in each risk category, an indication of the extent to which risks in a specific category might affect the project.
- Risk exposure ratio. This is the ratio of the impact of risks realized to the risk exposure of the project. This metric is evaluated on a monthly and cumulative basis. The formula to measure risk exposure ratio is equal to the sum of risk impact for risks realized/total risk exposure.
- Realized risk ratio. This metric determines the effectiveness of the risk management process. This assumes that risks are identified up-front and tracked periodically on the project. This metric improves the project's ability to identify, track, and mitigate risks. Evaluate this metric on a monthly and cumulative basis.
- Risk severity. This is a level of relative risk that includes the dimension of time (e.g., a risk severity category of 1 on a scale of 1 to 9 indicates the highest risk prioritized by risk exposure and time frame for action).
- Risk threshold. This is determined on quantitative goal. Risk threshold is a value that triggers a risk action plan. A notification is sent for variance above the threshold value.
- Risk indicator. This is the current value of project, process, and product measures monitored for risk (e.g., cost, schedule, progress, productivity, completion, change, staff turnover, quality, and risk).
- Risk management index. This is a summation of risk exposure in quantifiable terms for all risks as a percentage of total project cost.
- Return on investment. This is a summation of the savings for all risks divided by the cost of risk management.

6.9 Project Communication Management

This describes the collecting, processes for processing, sending and receiving the information to the appropriate channels. Projects have to develop a good communication plan and model so that right kind of information is available to the stakeholders at the right time. There are many barriers to communication which project managers have to overcome to deliver projects successfully. Project managers must explore all the possible channels of communication for better and accurate information exchange. 90% of the time of project manager is spent in the communication of project information to various stakeholders.

Communication has many dimensions such as written and oral; internal or external, formal or informal communication. Communication Plan contains the information about all the communication item, requirements, purpose, frequency, start/end dates, format/ medium, technologies, mode, and methods, and channels. Number of channels are n*(n-1)/2 where n is the number of people.

The communication plan also uses the information from Enterprise Environmental Factors and Organisation Process Assets for the existing communication data available. This helps project managers to understand the existing pain points and develop an improvised plan for the future communication needs. Communication Control is used to monitor and manage appropriate communication is delivered at the right time and various plans are updated i.e. Project Management Plan, Work Breakdown structure, Configuration Management Plan, and Risk Register along with Deliverable Documents. The modified information documents, plans, and documents are available to all the relevant stakeholders for their use and necessary actions.

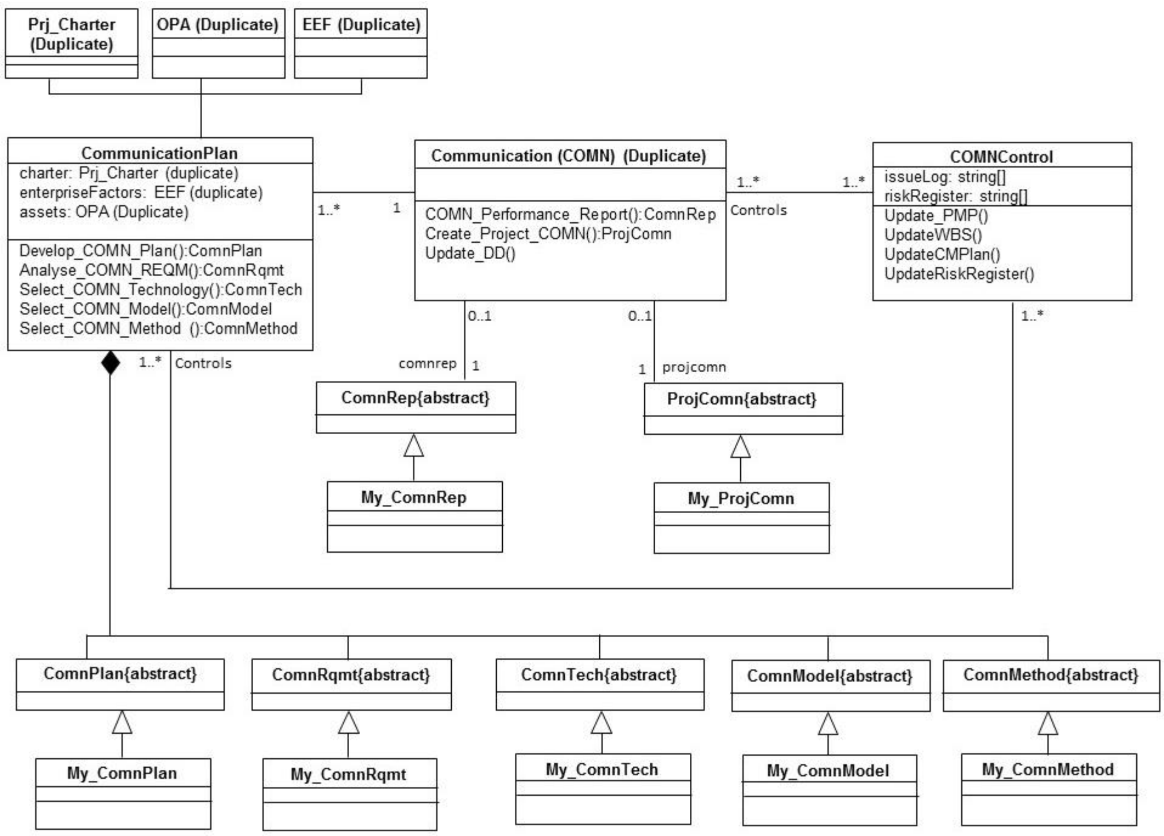

Figure 6.15 Project Communication Management

Project manager should:

- Develop the communication plan.
- Determine critical information flows with other projects (i.e., determine who needs to know what, and when).
- Establish formal lines of communication with other projects.
- Coordinate and approve significant communication initiatives (considering audiences, messages, channels, and timing).
- Ensure success factors for communication initiatives are developed.
- Arrange key briefings, discussions, and other meetings.
- Monitor the performance of communications.
- Identify and correct any gaps and redundancies in communication.

Table 6.19 Project Communication Management mapping

PMBOK[1] processes and activities (section)	**Formalised Model**
Plan communication Management (10.1.1 - 10.1.3)	CommunicationPlan class Operations: Develop_COMN_Plan():ComnPlan Analyse_COMN_REQM():ComnRqmt Select_COMN_Technology():ComnTech Select_COMN_Model():ComnModel Select_COMN_Method ():ComnMethod
Manage Communications (10.2.1 - 10.2.3)	Communication (COMN) class (Duplicate) Operations: COMN_Performance_Report():ComnRep Create_Project_COMN():ProjComn Update_DD()
Control Communications (10.3.1 - 10.3.3)	COMNControl class Operations: Update_PMP() UpdateWBS() UpdateCMPlan() UpdateRiskRegister()

6.9.1 Develop_COMN_Plan()

6.9.1.1 Determine Communication Objectives

Once identifying each communication event, determine the objective(s) of the communication materials that will support each event corresponding to the activities Plan communication Management (10.1.1 - 10.1.3) given in the Table 6.19. Communication objectives are the high-level messages to convey through the materials. These can accomplish the following:

- Increase awareness
- Gain interest
- Gain involvement
- Obtain buy-in
- Obtain commitment

- Obtain ongoing support

To determine the communication objectives:

- Review the communication objectives originally.
- Review each documented communication event.
- Determine which target audience(s) are affected by each communication event.
    - Refer to Stakeholder Expectations to determine which target audience(s) will be affected by each communication event.
- Determine what level of interaction supports the communication event across each target audience.
    - High (face-to-face, two-way interaction)
    - Medium (passive interaction requiring feedback/action for the recipients)
    - Low (passive interaction, informational purposes only)
- Document the communication materials objective(s) that support each communication event across the target audiences.
- Verify that the communication objectives identified for each communication event align with the communication objectives outlined in the communication strategy.

The objectives defined for each communication event will eventually serve as the basis for drafting communication materials.

6.9.1.2 Draft Communication Plan

The drafting of the actual communication plan will require inputs from all steps throughout this process.

To draft the communication plan:

- Define the format for the communication plan.
- Ensure the communication plan clearly outlines the following items (at a minimum):
    - Communication event
    - Objectives/key Messages
    - Audience
    - Planned delivery date
    - Actual delivery date
    - Vehicle
    - Sender
    - Developer
    - Reviewer
    - Approver
    - Feedback mechanism
- Complete the required fields for each communication event with the inputs gathered throughout this process.

Review the drafted plan with the primary communication sponsor.

6.9.1.3 Analyse_COMN_REQM()

Define Target Audiences

The target audience is the audience for which a communication is intended. Target audiences fall into categories such as:

- Those that implement the application delivery project (e.g., secondary communication sponsors)
- Those directly affected by the new application (e.g., system end users)
- Those affected by the new application but not directly involved with it (e.g., technical support/helpdesk representatives)
- Those who need to remain informed to ensure coordination throughout all affected areas of the organization (e.g., corporate communications, corporate training managers)

Target audiences may be segmented based on:

- Their knowledge of the project
- The level of information they require
- Their previous change experience
- The intended impact of the new application (low, medium, high) on this audience
- Their influence in the organization
- How much they affect the project's relative success
- Their current attitudes towards change

The level of detail within your communication plan directly relates to the number and degree of segmentation of your target audiences.

To define the target audiences:

- Review the Stakeholder Expectations and communication strategy
    - The stakeholder profile provides information regarding each affected stakeholder, including how much this change will affect the group.
    - The communication strategy includes information on the audience groups identified
- Work with the primary communication sponsor and deployment lead to identify which additional audiences to consider.
- Document the list of target audiences as they are defined. This document will serve as your target audience assessment. Include each target audience's size, physical location, and preferred channel for receiving communications.

6.9.1.4 Establish Communication Sponsorship

A primary communication sponsor was identified in the Analysis stage. Build a base of secondary communication sponsors who will support the ongoing communications across their respective groups throughout the application delivery project life cycle.

The primary communication sponsor will:

- Focus on company or organization-wide communication.
- Provide strategic direction for the communication initiatives.
- Act as the project sponsor for the new application.
- Send company or organization-wide communications.

The secondary communication sponsors will:

- Focus on specific group communications.
- Provide feedback on the specific communication messages and vehicles for their respective audience groups.
- Act as supporters of the application delivery project.
- Send communications to their respective groups, as appropriate.

To establish communication sponsorship:

- Create a role description that defines the communication sponsor's role. Include a description of the sponsor's base responsibilities, approximate time commitment, and value to the application delivery project.
- Review Stakeholder expectations to determine the appropriate number of audience groups needed to identify a secondary communication sponsor.
- Work with the primary communication sponsor to identify an appropriate secondary communication sponsor for each audience group.
    - This secondary communication sponsor must be respected for his or her leadership skills within the audience group, be known to value teamwork and inclusion, and have a history of responding positively to change.
    - Include the secondary communication sponsor's supervisor on all discussions regarding his or her participation in this role.
- Work with the primary communication sponsor to engage the secondary communication sponsors in their new roles.
    - Host a kick-off meeting for all secondary communication sponsors to provide an overview of the application delivery program and their role as sponsors.

Define this base of sponsorship early on and maintain it throughout the project.

6.9.1.5 Select_COMN_Model()

Identify Communication Events

A communication event is a key project event that will require some type of interaction with a target audience. Complete the following to identify the communication events:

- Determine which key events will require interaction with a target audience.
- Document each event that requires interaction with a target audience as a communication event.

6.9.1.6 Select_COMN_Technology()

Analyze Channel Options

A communication channel is the vehicle used to interact with the target audience. Common communication channels include e-mail, voicemail, newsletters, brochures, signs, electronic commercials (i.e., Flash presentations), and kick-off meetings.

To identify channel options:

- Work with the primary communication sponsor to identify the following:
  - Communication vehicles that are currently used in the organization
  - Communication vehicles not already in use that the organization would support
- Work with the secondary communication sponsors to determine which communication vehicles are best received by their respective workforce.
- Document your findings.
- Identify the appropriate communication vehicle for each communication event. You may list more than one vehicle to support each communication event.

6.9.1.7 Select_COMN_Model()

Determine Communication Sender

The communication sender is who the communication materials will appear to be sent from. Each target audience identifies the names of one or two sponsors with the application delivery program. Limiting the number of communication senders within each target audience will make the flow of information appear more consistent and cohesive. You may have multiple senders for each distributed message.

To determine the communication sender:

- Identify the communication events where the primary communication sponsor is the sender.
- Identify the communication events where the secondary communication sponsors are the senders.
- Document the appropriate sender for each communication event.

Determine Communication Reviewer and Approver

To determine the communication reviewer and approver:

- Identify the communication events where the primary communication sponsor is the reviewer and/or approver.
- Identify the communication events where the secondary communication sponsors are the reviewers and/or approvers.
- Identify the communication events where the deployment manager and/or additional project team members are the reviewers and/or approvers.
- Document the appropriate reviewer and approver for each communication event.

6.9.1.8 Select_COMN_Method()

Determine Communication Timeline

Complete the following to determine the communication timeline:

- Review the list of documented communication events.

- Review the training design and performance support design to match the communication events with the key events.
- Based on this review, determine the length of time before each event to communicate with the target audience.
- Document the approximate timing for each communication event.
    - If the deployment schedule is not yet finalized, use approximate time frames ("two weeks before training delivery") rather than concrete dates. If using approximate time frames during this stage, plan to update these timeframes to concrete dates as soon as the necessary schedules are finalized.

6.9.2 COMN_Performance_Report()

Describe and update the communication corresponding to the activities Manage Communications (10.2.1 - 10.2.3) in the Table 6.19.

Critical Questions

- Have you developed a Project Communications Plan that considers the what (e.g., issues), how (e.g., conference calls), when (e.g., weekly at 8 a.m. CST), and who (e.g., the project manager) for communication?
- Do your planned communications include all the information required by your stakeholders at the time they need it? Distributed work projects typically demand more detailed and more frequent written communication than single site projects.
- Have you budgeted for communication costs and the amount of communication time?
- Have you considered the cultural and language diversity of your team and its impact on communication?
- Have you rolled out the Project Communications Plan and ensured that team members understand it?
- Have you defined and communicated formal status reporting formats and procedures?
- Have you ensured that communications tools (e.g., SIR database, issues database, etc.) are accessible at all the sites?
- Have you considered the time difference between the sites when scheduling meetings?
- Have you scheduled all regular, repeating meetings? Do all participants understand logistics (conference call numbers and IDs, phone numbers for meeting rooms, etc.)?

6.9.2.1 List Communication Recipients

Create a list of communication recipients according to the different deployment stages.

- Business departments
- IT departments
- Pilot coordinator
- Project coordinator
- Roll-out coordinator

- External recipients
- Application management or operations team

The communication recipients may vary significantly by stage. Thoroughly review the communication recipients' list for the different stages; prevent the unaffected recipients from receiving dispensable information. Use communication channels according to recipient groups.

Add a contingency period between creating the recipients' list and the actual communication dates. This prevents delays and ensures timely information for the recipients.

6.9.2.2 Execute Communication Activities

Provide the right information to the right participants at the right time via the right channels. Consider the following content areas:

- Project activities and progress
- Roll-out information
- Legal requirements
- Application information (functional, technical, sizing guidelines)
- User procedures
- Deployment checklist
- Simulation and pilot information
- Support procedures
- Deployment success stories
- Application transition procedures

6.9.2.3 Evaluate Outcome

Evaluate every step and the outcome of the communication efforts. Evaluating the different communication stages is an iterative process. Incorporate the results of previous steps into subsequent communication activities.

Request support from areas of the organization to evaluate the communication. Most of the areas involved in the deployment stage are interested in the participants' evaluation and feedback on the communication quality.

Retrieve feedback on the value and effectiveness of the communication either via continuous personal contact with the recipients, evaluation reports, or the return rates of notification receipts. Secure feedback on the following:

- Satisfaction with the timely and complete delivery of the communication documentation
- The relevance and comprehensibility of the communicated information
- The correct addressee of the documentation

6.9.2.4 Assess Communication Effectiveness

Assess the communication effectiveness by analyzing the internal and external evaluation of the launch communication. Use the following criteria to measure effectiveness:

- Participation rates (simulation, surveys, etc.)
- Return rates (questionnaires, papers, etc.)
- Incoming calls from external recipients at the help desk

Compare the effectiveness with benchmarks (e.g., previous projects), cluster findings, identify gaps, and discuss ways to improve effectiveness with involved parties.

Different areas throughout the deployment stage require similar communication efforts; transfer the findings to other communication activities. Production and pilot participation, for example, require similar communication activities. Thoroughly observe and evaluate all problems, errors, or misunderstandings caused by misleading, faulty, or missing communication.

6.9.2.5 Assess Need for More Communication

Assess the need for more communication with representatives of the affected areas, according to evaluation results and the measured effectiveness corresponding to the activities Control Communications (10.3.1 - 10.3.3) given in the Table 6.19.

Identify reason(s) for additional communication requirements:

- Faulty or insufficient communication
- Communication unnoticed; sent at an inappropriate time
- Communication sent to the wrong addressee
- Incomplete list of recipients

Decide on the appropriate means of additional communication after assessing the need for more communication. Update or correct existing communication means, and re-send communication at different dates or to different/additional recipients.

The Project Management Plan, WBS , CMPlan ad Risk Registers are updated as required with the information received from various resources. This helps to monitor and control the project in more effective and efficient manner.

6.10 Project Procurement Management

This describes the processes for contract management for purchasing any services, results or products. The procurement management helps to make decisions for the organisation like make or buy; type of contract for the project. The contract types which organisation could go for are Cost Reimbursable, Time and Material, or Fixed price. Cost reimbursable could have more sub types such as Cost Plus Fee or cost Plus Percentage of Costs; Cost Plus Fixed Fee; Cost Plus Incentive Fee, Cost Plus Award Fee. Fixed types of contracts could be further divided into Fixed Price (lump sum); Fixed Price Incentive Fee, or Fixed Price Economic Price Adjustment. The objectives of Procurement Management are:

- Manage the acquisition of product/services from suppliers.
- Select product and service suppliers, using the decision analysis as required.
- Monitor and control supplier work status.
- Perform acceptance test and acquire the products.

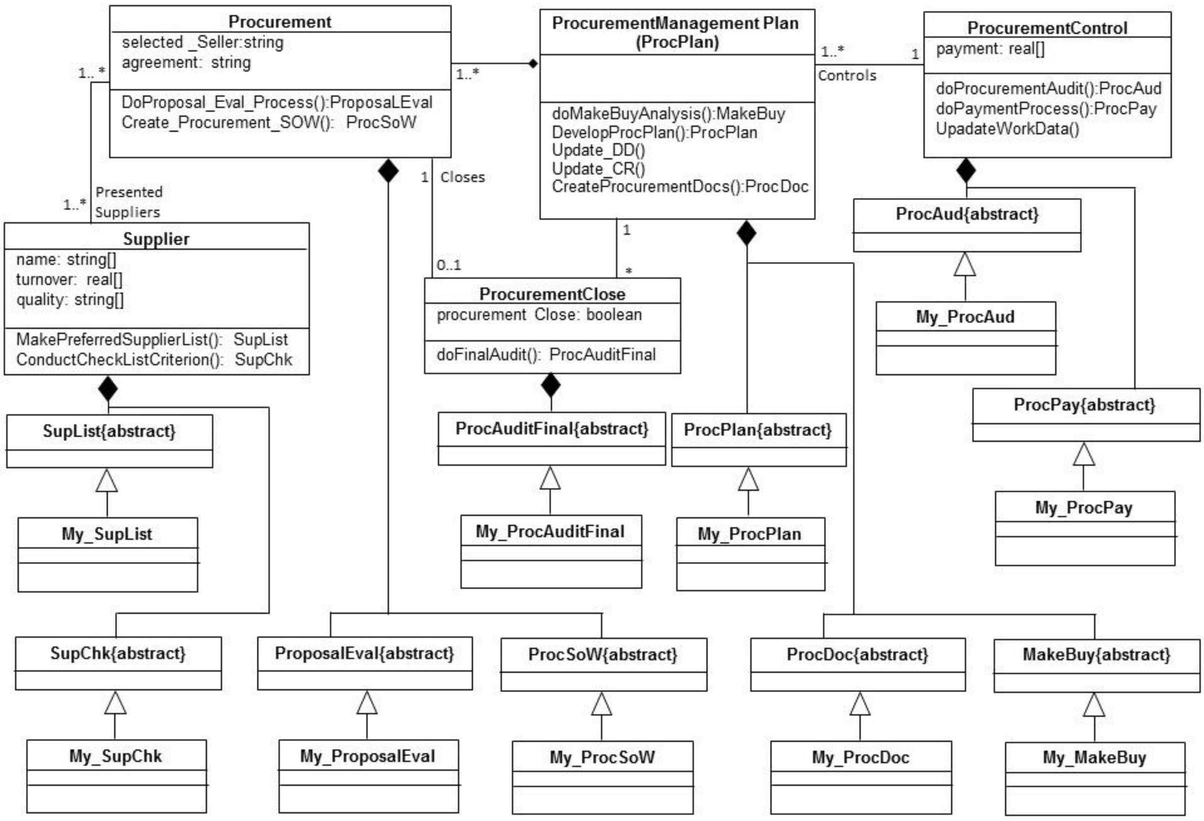

Figure 6.16 Project Procurement Management

The supplier is selected based on the criterion set by the organisation and the supplier could be one of the preferred suppliers. The evaluation process is well defined and Procurement statement of work is created for the deliverables or milestones to be achieved along with payment schedules. This helps to establish clear responsibility of the supplier and the buyer. Procurement documents are created, Procurement plan is developed based on the decision of make or buy analysis. Payments are made to the supplier based on procurement audit and following the payment process of the organisation.

The procurements are closed after the final audit when the supplier has delivered all the requirements as per the terms of reference.

Procurement Management manages the acquisition of products and services from external suppliers by establishing formal agreements.

This process area involves selecting suppliers, establishing and maintaining agreements with suppliers, executing the supplier agreement, accepting delivery of acquired products, and transitioning the acquired products to the project. Procurement Management does not include services for staff augmentation. The Procurement process is shown in Fig 6.17.

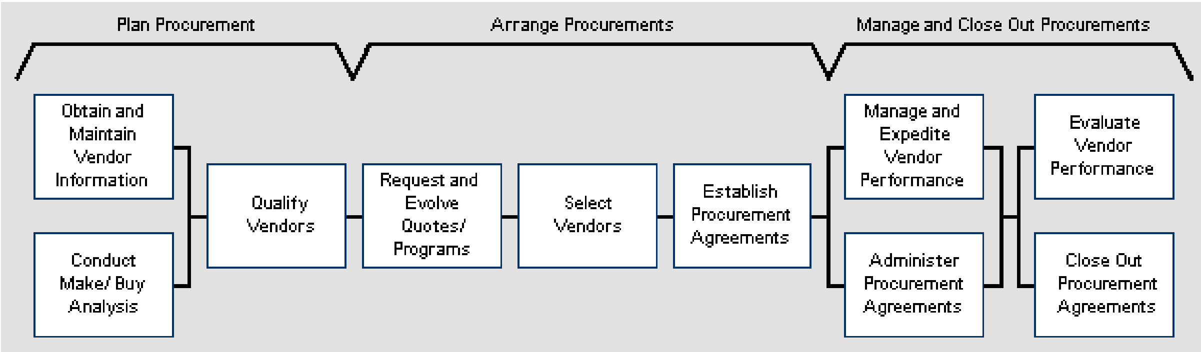

Figure 6.17 Procurement Process

Table 6.20 Project Procurement Management

PMBOK[1] processes and activities (section)	**Formalised Model**
Plan Procurement Management (12.1.1-12.1.3)	Procurement class ProcurementManagementPlan (ProcPlan) class Operations: DoProposal_Eval_Process() Create_Procurement_SOW() doMakeBuyAnalysis() DevelopProcPlan() Update_DD() Update_CR() CreateProcurementDocs()
Conduct Procurements (12.2.1 – 12.2.3)	Supplier class Operations: MakePreferredSupplierList() ConductCheckListCriterion()
Control Procurements (12.3.1 – 12.3.3)	ProcurementControl class

PMBOK[1] processes and activities (section)	Formalised Model
	Operations: doProcurementAudit() doPaymentProcess() UpdateWorkData()
Close Procurements (12.4.1 – 12.4.3)	ProcurementClose class Operation: doFinalAudit()

6.10.1 DoProposal_Eval_Process()

6.10.1.1 Develop Request for Proposal

Develop Request for Proposal (RFP) if suppliers have not been selected when the project started or if the project decides to subcontract specific services after the project has started. If the project has already identified only one supplier, they plan to contract with (a.k.a. "sole-source") then this step can be omitted defined in the activities Plan Procurement Management (12.1.1-12.1.3) given in the Table 6.20.

Third party agreements are separated into the following categories: Third Party Software, Hardware, and Related Services, Software license agreement, Software upgrade/maintenance, Technical professional services for hardware installation or training

Engagement with the person specializing in third party software/hardware agreements is recommended. The SME can inform the project team and contract management representative about alliances and third party agreements. It can also support them in the selection and development of the agreement for these products.

When selecting third party software, hardware, and related services, follow an orderly and systematic approach to identify and select products to find the "best fit" and "best value." The Product Selection Approach provides an approach that will:

- Identify and list viable products from the marketplace
- Narrow the list of finalists based on screen criteria
- Select the best solution for the project using comprehensive questionnaires and business scenarios

6.10.1.2 doMakeBuyAnalysis()

Conduct Make/Buy Analysis

Based on discussions with program management, and working from the most current and detailed procurement requirements information available, conduct the make/buy analysis by doing the following:

- Qualify the ability of goods and services suppliers to meet the identified requirements.
- Perform a make/buy comparison.

6.10.2 MakePreferredSupplierList()

6.10.2.1 Evaluate Suppliers

Evaluate suppliers and select the one that best meets the project requirements and the supplier selection criteria as per the activities Conduct Procurements (12.2.1 – 12.2.3) given in the Table 6.20.

Suppliers are classified as authorized (Strategic, Preferred, Approved, Mandatory), or non-authorized. Our organization applies a code to each supplier to indicate the type of business relationship our organization has with that supplier. The Program Management Office (PMO) or the central technical support team typically maintains a list of authorized suppliers which can be contacted for any standard products/services.

For first time suppliers or suppliers with non-standard products/services, follow these steps for supplier selection:

- Collect the supplier information.
- Conduct evaluation.
  - Fill out the Selection Scorecard for each supplier. The supplier rating and evaluation mechanism is given in detail in the Supplier Selection Scorecard Template (MS Word).
  - For each supplier, compute the supplier rating.
  - The supplier with the highest score is the most probable candidate for selection.

The Procurement Process Guidelines introduces the work activities and associated information requirements for the procurement of goods and services. This is a mandatory process when using vendors and procuring goods and services.

6.10.2.2 ConductCheckListCriterion()

6.10.2.2.1 Qualify Vendors

For procurements that do not require a make/buy analysis, qualify vendors of the required goods and services. Prepare vendor short lists showing the results.

Qualifying vendors encompasses confirming a potential vendor’s capability to provide required goods and services and the desirability of doing business with that vendor based on its reputation and financial stability. For the particularly significant program procurements, vendors are qualified in earlier stages.

6.10.2.2.2 Establish Subcontract

Once the supplier has been selected, a subcontract is prepared and negotiated with the selected supplier. This subcontract describes the terms of engagement, service levels, pricing, etc.

Identify and approach the appropriate Legal and Commercial contact to establish a Subcontract. Use the Subcontract to document supplier agreement and responsibilities.

The Legal & Commercial (L&C) Contract management representative is responsible for:

- Performing subcontract administration, including modifications, task orders and subcontracts
- Working with the project manager and supplier to determine, communicate, and address possible changes to the subcontract
- Monitoring subcontract compliance
- Providing a contract administration document library
- Providing support for subcontract plans
- Providing project management support, including contract deliverables tracking, risk/issues tracking and invoice/payment tracking
- Providing subcontract awareness training
- Providing contract management best practices

The following principles apply to the subcontracting efforts:

- Clearly define the scope and timescales for the provision of goods or services.
- Make sure that the terms of the subcontract are consistent with the provisions in the prime contract with the client, including applicable flow-down clauses.
- Clearly state any consideration of the terms contained in other related agreements such as Teaming Agreements.
- Clearly define the value of the contract and payment terms and conditions.
- Define the change process.
- Define the deliverables.
- Clearly state the acceptance criteria for supplier deliverables.

A purchase order is required in order to pay the supplier for the supply of a particular product or service. The purchase order will have the details of product, quantity ordered, rate, shipment address, terms of payment, date of delivery, etc.

6.10.3 doProcurementAudit()

6.10.3.1 Monitor and Expedite Vendor Performance

This is normally performed by the procurement function for commodity type items as described in the Control Procurements (12.3.1 – 12.3.3) given in the Table 6.20. This involves the following activities:

- Monitor vendor progress against the procurement timeline, and expedite that progress to ensure on time delivery.
- Check vendor compliance against the terms and conditions of the procurement agreement. This often includes an expanded, more rigorous set of monitoring activities, including the following:
    - Reviewing deliverables for conformance to requirements and accepting completed deliverables. You can use prototyping, walkthroughs, and testing to ensure conformance to requirements.
    - For cost reimbursement procurement agreements, reviewing schedule performance and cost/effort performance.
    - Reviewing the vendor management and work processes for conformance to policies and standards.
    - Expediting and taking corrective actions as needed to ensure on time, on-specification delivery.

The amount of time and effort devoted to this activity is directly proportional to the importance of the goods and services being procured. Coordinate closely with procurement managers and others to ensure that each clearly understands the role to play in monitoring each active procurement.

Record the acceptance of procured goods and services in accepted purchased goods and services reports. These reports are equivalent to accepted receiving reports; like the purchase agreements, they support the payment of supplier billings. Route copies of these reports to program management and procurement to advise them that the procured items were received and accepted.

6.10.3.2 doPaymentProcess()

Administer Procurement Agreements

This activity involves the following steps:

- When requirements change or are not adhered to, negotiate changes to purchase orders, subcontracts, and other procurement agreements.
- Maintain official copies of procurement agreements and any changes to those agreements.
- Maintain records of the following:
    - Change status (e.g., proposed, agreed, in process, completed, billed, and paid)
    - Procurement status (e.g., progress, performance, deliverables accepted, and completed)
    - Disputes and their status

Maintaining the procurement status information is primarily based on the receipt of accepted purchased goods and services reports that certify the receipt of some or all of the procured items. These reports identify any problems with the procured goods or services.

Document any significant, unresolved problems as issues or open points for analysis of and reporting on the overall program performance.

6.10.4 doFinalAudit()

Accept Purchased Goods and Services

Ensure that the program has the facilities to receive, store, use, and maintain the product being purchased or created for the program as given in the Close Procurements (12.4.1 – 12.4.3) activities in the Table 6.20. Verify that the appropriate personnel on the program or project are trained on the product. Verify that the product is stored, distributed, and used according to the supplier agreement or license.

7. Programme Management

7.1 Introduction

According to PMI [1, 77] program management is defined as the centralised coordinated management of a program to achieve the program's strategic objectives and benefits. Projects within a program are related through the common outcome or collective activity. If the relationship between projects is only to that of a shared client, seller, technology or resource, the effort should be managed as a portfolio of projects rather than as a program. Program manager functions at the strategic level; align multiple projects to optimize achievement of goals, provide a comprehensive approach to resource allocation across the organization, support the execution of executive level portfolio management, initiate Projects, assign Project Managers, work both within and external to their organization in managing complex programs that may span organizations. In addition, the program manager should have advanced skills in finance, cross-cultural awareness, leadership, communication, influence, negotiation and conflict resolution

P3M3 [3] describes a programme as a temporary, flexible organization created to coordinate, direct and oversee the implementation of a set of related projects and activities in order to deliver outcomes and benefits related to the organization's strategic objectives.

V.K.Rai and N.Swaminathan [78] discussed a systematic framework for program management having three related aspects of value realisation, program construction, and program execution. They defined program as a system of systems which takes into account various features and components of each project and relate them with overall structure. The model is developed iteratively to address all the activities and information flow across the framework.

Team management had been stressed as the most important concept in program management by L.M. Oliva [79]. Author suggested that increase use of integration technologies like computer aided engineering, manufacturing, etc. requires better team coordination and trainings. The workforce had reduced due to use of technologies, organisational structure had been made more horizontal and team management is one of the significant requirements for managing large scale complex programs.

L.N. McFarlane et.al [80] discussed the use of simulation programmes for training program managers so as to enable them with better management of complex programs. Since programs are always large, complex, and of longer duration hence there is quite a lot of uncertainty in taking decisions. The simulated environment of training had been proposed for program manager so that they would be able to use their skills and experience to arrive at a decision and test it in risk free simulation and see the projected outcome.

K.M. Marcroft [81] defined the processes, and methods for reducing the risk on software development programs. Author studied program management techniques used for hardware development and suggested changes along with rationale to use them for software development.

Defence research programs are generally large, costly and complex than other programs of government. Cakmark and Gokpinar [82] discussed the application of decision making approach for managing Turkish Space program. The paper suggested that for effective management of such a large program web model with grading process for work break down structure as per the technology evaluation matrix should be used.

D.G.Bell et.al [83] discussed unique process for program management and business intelligence for an organisation like NASA. The process used business documents as user interface and schema less XML database for making integration of information easier for automation. The implementation is based on NASA Program Management Tool and Netmark-its schema-less database. The benefits are reduced paper work and easier retraceability of business requirements to final management reports.
In this chapter, method and processes are described for programme management.

7.2 Features of Program Management

The proposed Program Management approach focuses on planning, mobilizing, and managing a program at a client site.

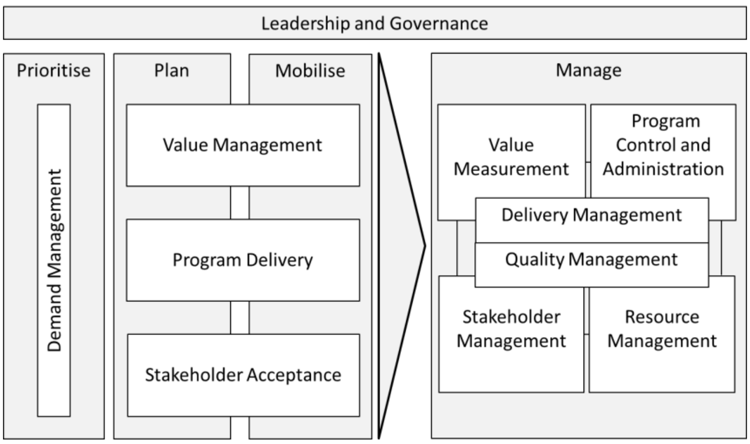

Figure 7.1 Program Management Methodology Framework

It includes the following critical areas for planning and mobilizing a successful program:

- **Demand Management.** This is for balancing the workload of the program by assessment of the priorities of proposed projects with the capacity to perform the work and aligning of the projects with the overall strategy.
- **Leadership and Governance.** Defines the structure and objectives for the group guiding the overall goals of the program and determines how best to coach leadership.

- **Value Management.** Defines the business case, value metrics, and value measurement approach for the program.
- **Program Delivery.** Defines the management approaches, schedule, timeline, budget, scope, and metrics for the program. Identifies vendors, tools, and resources. Establishes the program management office.
- **Stakeholder Acceptance.** Identifies and analyses stakeholder expectations. Determines how to ensure the program results acceptance by multiple levels of customers. Creates initiatives to cultivate program acceptance.

It includes the following critical areas for successfully managing an existing or newly created program:

- Value Measurement. Measures the value achieved by the program against the value expectations set in the business case. Provides on-going management of the business case.
- Program Control and Administration. Coordinates all program activities, reports, and other deliverables. Manages finances, contracts, record keeping, and knowledge management.
- Delivery Management. Monitors and controls projects under the guidance of the program and manages the release schedule.
- Quality Management. Manages and oversees the program's adherence to quality processes and standards. Works with stakeholder management to monitor and manage stakeholder expectations and satisfaction. Identifies and acts on opportunities for improvement.
- Stakeholder Management. Monitors and manages stakeholder expectations throughout the life of the program. Monitors the effectiveness of change initiatives and program acceptance, and makes adjustments as needed.
- Resource Management. Manages all program resources, including personnel, vendor relationships, physical work environment, facilities, and equipment.

The methodology does not cover:

- Selling work to the client
- Strategic planning and business architecture
- Long term planning for transformational change or outsourcing
- Project-level management

7.2.1 When to Use This Methodology

This methodology is designed for the following circumstances:

- You are planning, mobilizing, or managing a single program.
- You have determined what value you are providing the client though the program.
- You and the client agree on the program objective.

- A program agreement with the client is already in place. This may take the form of a solution value diagnosis, rough business case, contract, or a program roadmap that roughly maps out the timeline for delivering the proposed value. Additional work on these deliverables is expected and accommodated within this methodology.

7.2.2 Integration with Project Management

This fits with the Project Management by providing:

- The high-level estimate for the project via the budget for the program
- Program Management Approaches that serve as the starting point for individual Project Management Plans
- Standard orientation and training materials for all projects to use
- Policies and standards, including methods guidelines
- Vendor contract and management support
- Team work environment and facilities support

The program handles all upper management reporting, financial statements, contract negotiations, and fulfilment of the program business case. The project provides the program with all necessary reporting metrics and to fulfil the project's business case.

7.2.3 Integration with CMMI

A standard methodology is one of many components that are assessed when an organization aspires to operate at a particular certification or quality level.

- Capability Maturity Model Integrated (CMMI)
- eSourcing Capability Model (eSCM)
- People Capability Maturity Model (P-CMM)

7.3 Programme Management Structure overview

This overview explains:

- The framework for the methodology
- The main content types and how they relate to each other
- The supplemental content types available to help you

The vertical bars in shown in the Figure 7.1 are the stages of work within a program.

- **Prioritize.** Balance the program's workload by evaluating the priorities of proposed projects with the capacity to perform the work and how the projects align with the overall strategy.
- **Plan.** Define the program's scope, objectives, and structure. Establish the program's timeline, schedule, and budget. Develop the business case and the stakeholder acceptance approaches.
- **Mobilize.** Roll out the program plans by performing detailed design and implementation of program policies, standards, training, work environment, tools, and vendor arrangements.

- **Manage.** Run the program according to the Program Management Approaches and Program Plan established during the Plan stage. Monitor program execution, and continuously improve the program.

The horizontal bars shown in the Figure 7.1 are workstreams defined as a domain or area of work. Workstreams group the tasks usually performed by a team of people with related skill sets. For example, Leadership and Governance defines the structure and objectives for the group guiding the program's overall goals and determines how best to coach leadership.
Each box in the diagram shows an activity. For example, Program Delivery means the Program Delivery activity (Figure 7.2).

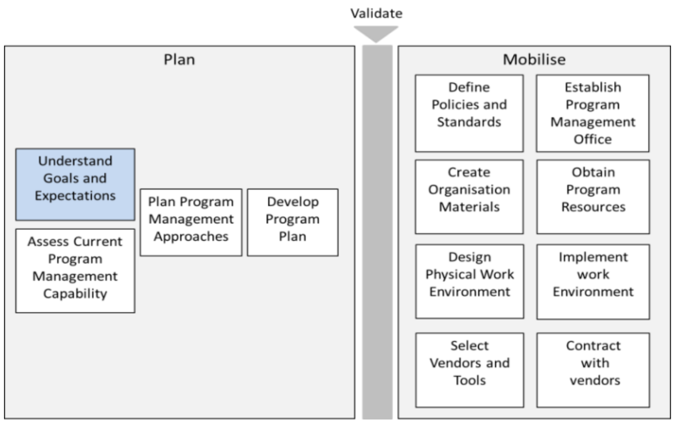

Figure 7.2 Program Delivery Activity

Each box on the activity diagram opens a task (the lowest process level in the methodology). Blue boxes indicate tasks that involve members of this team but are the responsibility of another team. For example, Understand Goals and Expectations in Figure 2 is the responsibility of the Stakeholder Acceptance activity, but it requires involvement from all program areas to complete effectively.

The framework shows as a simple matrix and is not meant to show time dependencies between the different workstreams. For example, all three Plan and Mobilize activities (Value Management, Program Delivery, and Stakeholder Acceptance) do not happen simultaneously; each workstream has interrelated dependencies that require some activities to precede others. However, they all begin during the Plan stage.

7.4 Primary Methodology Content Types

There are three key types of content in the methodology:

- Processes define what you need to do.
- Deliverables are what you need to produce.
- Roles tell who needs to do it.

These three content types reference each other to form the foundation of the methodology (Figure 7.3).

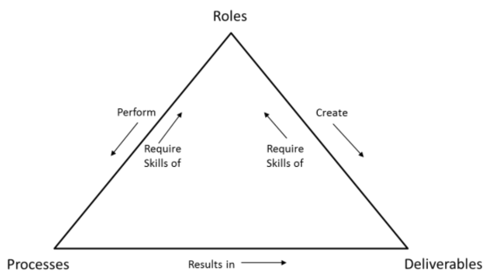

Figure 7.3 Primary Methods Content

7.4.1 Processes

In this methodology, there are two levels of process documents:

- Activities are large units of work with a single major outcome. They are composed of tasks.
- Tasks are smaller units of work performed by one individual or team to create a single primary outcome. Tasks are composed of steps.

7.4.2 Activities

Activity documents are written primarily for the project's manager or team lead. Figure 7.4 shows the 11 activities in this methodology:

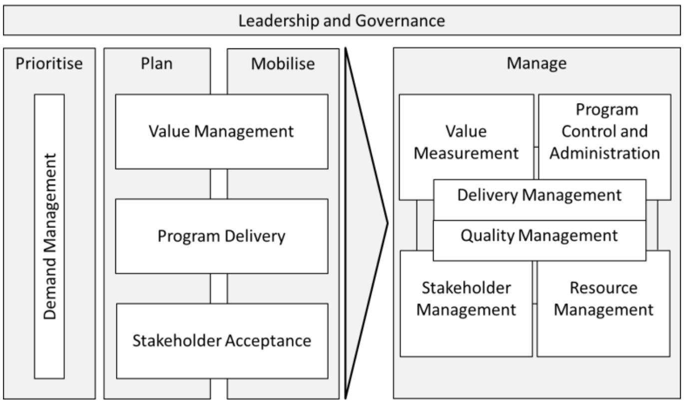

Figure 7.4 Activities within the Method

In complex activities, the tasks may be organized into sub-workstreams, based on the skills needed to perform the tasks. This methodology does not use sub-workstreams.

Each activity contains the following information:

- Planning Chart. This is a schematic of tasks for the activity, showing their sequence and relationship.
- Deliverable Flow. This is a schematic of deliverables for the activity. Toggle from the process view to the deliverable view by clicking a link immediately below the schematic.
- Objectives. This lists the principle objectives and outcomes of the activity.

- Inputs and Deliverables. This shows the inputs and outputs of the activity, grouped by which deliverables are critical (primary) and which are useful but not essential (secondary).
- Roles. This describes the skill sets required to execute (responsible roles), assist, or review the work (secondary roles).
- Relationship to Other Workstreams. This describes the dependencies between this activity and activities in other workstreams.
- Considerations. These are the key issues to consider for planning, managing, staffing, and successfully completing the activity.

7.4.3 Tasks

Task documents are written for the team member executing the work. In each task, you will find the following information:

- Planning Chart. This is a schematic of steps for the task.
- Objectives. This lists the activity's principle objectives and outcomes.
- Inputs and Deliverables. This shows the inputs and outputs of the task, grouped by which deliverables are critical (primary) and which are useful but not essential (secondary).
- Roles. This describes the skill sets required to execute (responsible roles), assist, or review the work (secondary roles).
- Process Steps. These describe each step in the planning chart.
- Key Considerations. These are the key issues to consider for planning, managing, staffing, and successfully completing the activity.

7.4.4 Deliverables

Deliverables contain the following information:

- Description. This provides a short description of the deliverable.
- Roles. This describes the skill sets required to execute (responsible roles), assist, or review the work (secondary roles).
- Template. Many templates can be created using MS office or other tools for help in completing the deliverables.
- Sample. This is an example of a completed deliverable.
- Customers. This briefly explains of who is dependent on this deliverable and why.
- Where used. This lists the processes that create, update, and use this deliverable as an input.

A composite is a grouping of related deliverables into a single object. For example, the Program Plan composite is composed of the following:

- Work Plan
- Schedule and Milestones

- Resource Plan
- Budget
- Organization Chart
- Dependency Chart
- Release Plan
- Program Scope and Project Statement of Work

Each Program Plan composite can contain zero, one, or many instances of each of its child deliverables. Collectively, however, all instances of these deliverables serve one purpose in executing and controlling the program.

7.4.5 Roles

Roles are the skill sets needed to complete a task. A person on a team may have one or more roles on the project. Similarly, more than one person on a team may share a role.

There are two types of roles in the methodology:

- Responsible roles are primarily responsible for completing a task or deliverable.
- Participating roles assist in completing a task or deliverable by reviewing the work or providing the expertise.

Each role description in the methodology provides the following information:

- Role responsibilities
- Tasks the role is responsible for
- Tasks the role participates in
- Deliverables the role is responsible for
- Deliverables the role participates in
- Additional resources for the role

7.4.6 Supplemental Methodology Content Types

In addition to the main object types, the methodology provides additional assistance for users in the form of job aids, checklists, and external resources.

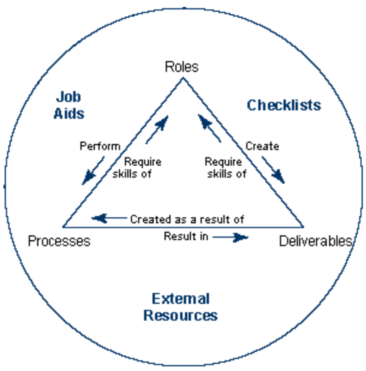

Figure 7.5 Supplementary Methods Content

7.4.7 Job Aids

Job aids provide additional guidance for completing a task or deliverable. There are three types:

- Overview. This deliverable provides a description of key concepts and background information.
- Guidelines. This deliverable provides specific information on issues, considerations, and approaches for completing a task.
- Technique. This deliverable provides specific information on a specific approach or method of achieving a result.

7.4.8 Checklists

Checklists provide tools for quick quality checks at key points in the process. Each checklist includes an attachment, allowing you to easily download a copy of a checklist, customize it as necessary for your project, complete it, and store it with your project deliverables.

7.4.9 External Resources

External references are links to additional resources outside this methodology, including references to internal databases, web sites, book descriptions, and other methodologies.

7.4.10 Deliverable and Process IDs

Each process and deliverable in this methodology has an identifying ID code.

- Processes have a four-digit numeric identifier.
- Deliverables have a five-character alphanumeric identifier.

Process IDs

Process IDs take the following form:

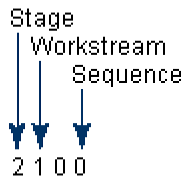

Figure 7.6 Process ID Structure

- The first digit defines the activity stage. For example, all activities in the Plan stage start with the number 2.
- The second digit defines the activity's workstream. For example, all activities in the Stakeholder Acceptance workstream have a second digit of 5.
- The third and fourth digits define the process' sequence. For example, the Value Management activity has an ID of 2200 ("00" indicates an activity); Develop Business Case, a task in Value Management, has the ID 2211.

Deliverable IDs

Each composite and deliverable has an ID with the form PGXXX, where PG stands for Program, and the three following digits indicate the following:

- The first digit defines the stage where you create the deliverable. For example, plan deliverables all have the number 2 as the first digit.
- The second digit defines the workstream of the deliverable, where applicable. For example, the Capacity Plan, created during Demand Management (1100), is PG116.
- The third digit defines the approximate sequence of deliverables relative to other deliverables.

Composites always end in the number 0. Its children usually have the same first four characters in their IDs.

7.5 Leadership and Governance

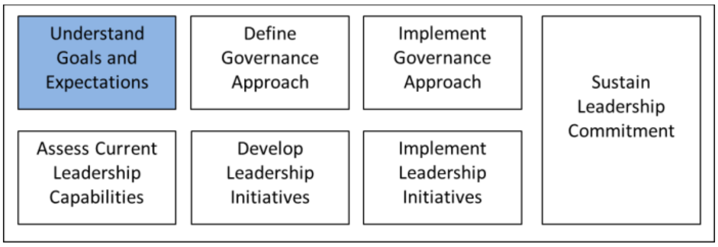

Figure 7.7 Leadership and Governance

Objectives

- Create a leadership mindset and enable leadership to lead the program and accomplish the strategic objectives of the program.
- Establish and operate an effective governance team that navigates and provides direction for the program and projects.

Demand Management

- The governance team reviews any new work proposed by the demand management team and makes the go or no-go decision. Demand Management receives input and direction from the governance team on potential new work to explore based on discussions with the senior leadership sponsor and other key stakeholders.

Value Management and Measurement

- Value Management and Measurement works with the governance team to define value and obtain direction on how to manage and measure value. Upon establishing the value definition and metrics, the value management and measurement team ensures the program and project leadership buys into the value definition, and incorporates quality and measurement practices that link to the achievement of that value.

Program Delivery

- Leadership and Governance oversees program delivery. It provides direction to the program and ensures that the program is progressing as planned and achieving the objectives outlined in the business case.
- Stakeholder Acceptance and Management
- Stakeholder Acceptance and Management works closely with Leadership and Governance to identify all key stakeholders for the program. The leadership and governance team are a key stakeholder group that the stakeholder acceptance and management team focus on. Stakeholder Acceptance and Management ensures that the leadership and governance team members demonstrate strong sponsorship ownership, and commitment to the program and projects.

Quality Management

- The quality management team obtains direction from the governance team on the important quality factors. The quality management team then works with program and project leaders to incorporate quality into the deliverables or outcome.

7.6 Demand Management

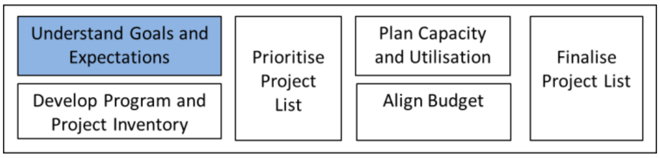

Figure 7.8 Demand Management

Objectives

- Create a comprehensive, prioritized list of project and initiative requests that meet business needs.
- Determine the delivery organization’s capacity to deliver these initiatives and align it to the prioritized list of projects.
- Determine program funding levels and align them to prioritized list of projects.
- Produce a finalized, ranked project list that aligns with the program budget & capacity.

7.7 Value Management

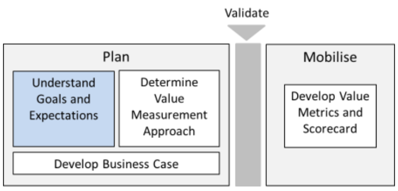

Figure 7.9 Value Management

Objectives

- Work with client executives to develop and agree on a complete and exhaustive value measurement approach

- Develop a business case to substantiate that the program's contribution to the client's value creation justifies program costs and investment
- Structure scorecards and metrics to effectively monitor and drive realization of the forecast program value

7.8 Program Delivery

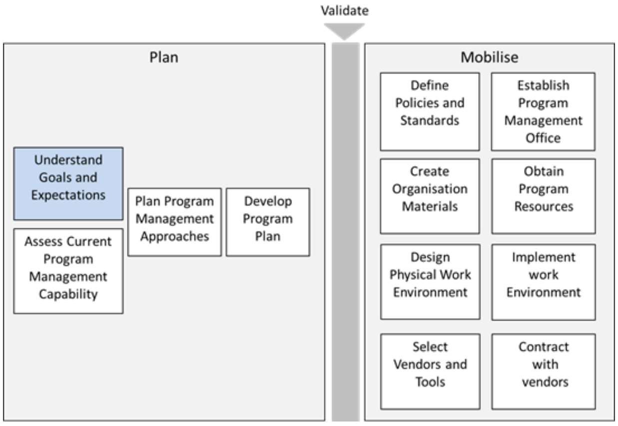

Figure 7.10 Program Delivery

Objectives

- Identify and create the management processes needed to run the program successfully.
- Develop a program-level plan that delivers the agreed upon business value.
- Satisfy the goals and expectations of the program's stakeholders.

7.9 Stakeholder Acceptance

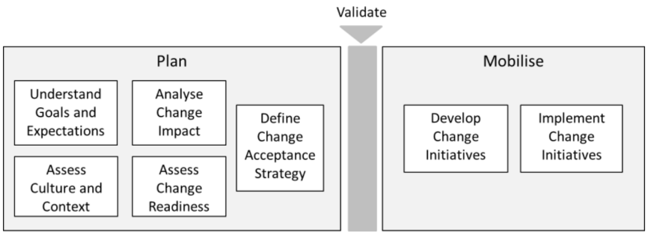

Figure 7.11 Stakeholder Acceptance

Objectives

- Understand and manage stakeholder expectations throughout the program.
- Assess the overall organizational capacity to change and identify potential barriers to change.
- Identify organizational strengths and weaknesses to understand factors that may support or inhibit change.
- Identify the degree of impact the program will have on stakeholder groups.
- Assess the overall sponsors' and stakeholders' readiness and willingness to change.

- Develop a comprehensive Change Acceptance Strategy that ensures the intended change will be both understood and accepted by all affected parties.
- Develop and implement change initiatives and incentive programs that keep stakeholders and sponsors engaged and committed throughout all stages of the program.

7.10 Value Measurement

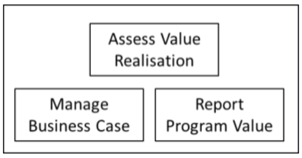

Figure 7.12 Value Measurement

Objectives

- Manage and measure value realization throughout the program life cycle.
- Provide project and program managers with value analysis data to facilitate corrective actions identification.
- Determine the impact of program changes on the business case and reforecast value creation.
- Provide stakeholders with a value-driven guidance of the change program.
- Verify and validate the results of program initiatives with program sponsors and stakeholders.

7.11 Stakeholder Management

Figure 7.13 Stakeholder Management

Objectives

- Manage stakeholders throughout the life of the program.
- Understand and manage stakeholder expectations of the various projects.
- Assess ownership and commitment to the change journey at various points in the program life cycle.
- Validate and verify that ownership and commitment levels are aligned with where the project is in the life cycle.
- Manage the approved change initiatives and incentives at the program level.

- Verify and validate results of change initiatives and incentives at the program level; make adjustments as needed.
- Provide program guidance and guidelines to the associated projects with regards to stakeholder management.

7.12 Delivery Management

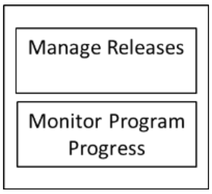

Figure 7.14 Delivery Management

Objectives

- Implement the coordination and management functions needed to ensure a quality product within a given release.
- Track the progress of the program and related projects against plan.

7.13 Quality Management

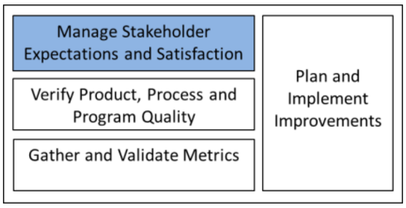

Figure 7.15 Quality Management

Objectives

- Ensure that stakeholder expectations, quality objectives, and program requirements are defined, understood, implemented, and actively managed.
- Execute and maintain the processes defined in the Quality Management Approach.
- Verify that the program results meet the standards.
- Verify that quality processes are followed and meet the applicable standards.
- Gather and validate that the metrics meet the objectives. Take required corrective action if necessary.
- Implement any needed program improvements.

7.14 Program Control and Administration

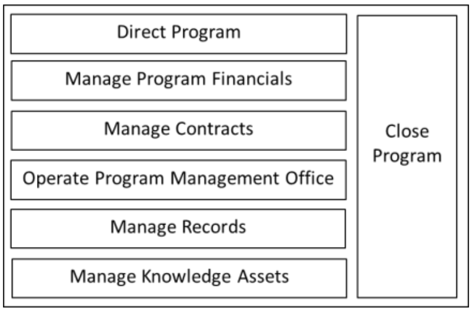

Figure 7.16 Program Control and Administration

Objectives

- Provide visible and consistent program leadership, direction, and focus.
- Ensure program and project activities align with overall program objectives.
- Manage the control and coordination of program-wide approaches, policies, and infrastructure functions to maximize program performance and delivery.
- Manage the control and coordination of program-wide approaches and infrastructure functions to ensure compliance with financial, contractual, and legal requirements.

7.15 Resource Management

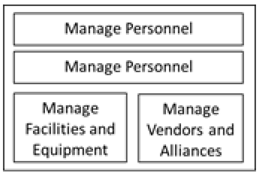

Figure 7.17 Resource Management

Objectives

- Efficiently and effectively provide all resources required by the program and its projects on a rolling basis.
- Enable projects to meet their schedule, budget, and business case by the timely acquisition, maintenance, and release of quality resources.
- Track acquisition and usage of all program resources.
- Meet cost and other metrics criteria for resources, as established by the Resource Plan, Program Metrics Plan, Business Case, and Financial Plans.

Monitor the quality, timeliness, and effectiveness of vendors and other resources to ensure they fulfil their requirements.

7.16 Summary

In this chapter, high-level model has been proposed for the Programme Management. The high-level models provide the structure and flow to the managing large scale complex programmes. This high-level model also describes the various work streams, critical areas for planning and mobilising a successful program along with description of leadership and governance required. The methodology proposed is well aligned and integrated with project management standards as well as maturity models like CMMI.

This methodology will be of great help to create meta models for the programme management and hence can be used to create automated tools for programme management.

8. Development Process Patterns for Distributed Onshore/Offshore Software Projects

8.1 Introduction

The globalisation of the commercial world, and the use of distributed working practices (Offshore/ onshore/ near-shore) has increased dramatically with the improvement of information and communication technologies. Many organisations, especially those that operate within knowledge intensive industries, have turned to distributed work arrangements to facilitate information exchange and provide competitive advantage in terms of cost and quicker delivery of the solutions. The information and communication technologies (ICT) must be able to provide services similar to face-to-face conditions. Additional organisations functions must be enhanced to overcome the shortcomings of ICT and also to compensate for time gaps, cultural differences, and distributed team work. The proposed model identifies four key work models or patterns that affect the operation of distributed work arrangements, and guidelines have been proposed for managing distributed work efficiently and effectively.
People and organisations have been communicating and managing work over long-distances and multiple countries since ancient times also. Earlier, such distributed work and exchange of information was achieved by the physical travel of people, which made the flow of information slow and coordinating the work tedious and also costly.

With the exponential growth of information and communication technologies (ICT), the globalisation of the commercial world has also increased dramatically. Armstrong and Cole [43], emphasises that the growth of distributed work is because organisations aim to increase efficiency, productivity, quality and cost effectiveness.

F. Salger et.al [44] described the importance of software requirement specification (SRS) document to the success of global software projects. The authors discussed various difficulties in creating a standard SRS as companies have their own methods of creating such documents. The authors studied how Capgemini overcame this issue by using specification patterns so as to create synergy among the global teams. The significance of knowledge sharing among global teams and stakeholders and how it can be addressed by mature processes and tools is highlighted by F. Salger et.al [45]. There will be lesser readjustment required if the processes, methods and tools are used enterprise wide. The authors proposed that enterprise wide software should be used for project assurance, quality and knowledge sharing.

Narayanan et.al [46] described the team structure for successful completion of offshore projects. The authors studied two types of structures for offshore teams and highlighted the problems faced by managers for changing the team structure and organisation model. They also proposed that changes have to be done to the existing structure for successful global operations.

A framework for managing risks in global software projects is proposed by J.S. Persson et.al [47]. The framework had been created for distributed projects based on various parameters and requirements of global environment.

H.H. Khan et.al [48] studied the impact of communication media like email, messaging, phone etc. on the conflict resolution in global teams. The authors tried to evaluate which could be the best sequence or combination of media tools for communication for resolving the conflicts.
Lane and Agerfalk [49] tried to analyse the global development projects using framework so as to overcome various issues in the distributed projects. The authors tried to study the processes used by various organisations to manage the distributed projects efficiently and effectively, and maximise the benefits of onshore-offshore delivery.

T. Niinimaki [50] studied different communicating media and its application the global agile software development projects. The authors found that instant messaging is a good substitute tool for face to face communication and email is good tool for wider and enterprise wide information sharing.

Predicting the outcome of global software development projects with the application of analytical modelling had been studied by R.M.Czekster et.al [51]. The analytical models are parameterised to accommodate the single-site or multi-sites, team sizes, skills levels, expertise, availability, and support level etc.

Managing a multi-site software development project is complex and requires a very good collaboration among teams [52]. The same can be improved using networked virtual environment which allows for better communication, familiarity, sharing, mentoring, faith and faster resolution of conflicts.

J.Hashmi et.al [53] had studied the growth of teams in distributed software development projects. The authors had tried to study the growth of teams in terms of expertise, communication skills, economic impact and working conditions.

Hinds & Bailey [54], describes "Distributed Work" as a number of different work arrangements. The teams are separated by geographical distances, time zones, and the team have to rely on the availability and efficiency of information and communication technologies.
Bret Swan et.al [55] discusses application of incentive based theories to the distributed work environments and address two issues; firstly, the effect of incentives on the worker's choice to use distributed work environment and second the interaction of multiple incentives or disincentives across organisation, group or individual. This paper also looks into the reasons

why people don’t always adopt distributed work environments and applies this incentive based theory to two organisations.

Bailey and Kurland [56] discussed the use of Distributed work environments to reduce costs, improve productivity and motivate employees, with positive impact on group outputs.
Even though there is positive impact on the employees for the work-life balance, more flexibility but there are contradictory results due to more distractions at home and hence increased stress [57-62].

Varied results from the work put organisations in difficult situations for the standardisations of processes to implement distributed work environments. Previous researchers have implied that this may be due to the lack of well-established framework for distributed work environments. One of the solutions could be to use the standard organisational theories to overcome the problems of distributed work environments. Even these theories are not sufficient to address the issues of the distributed work environment.

This chapter proposes a new set of frameworks and identifies five models for using the distributed work more efficiently and effectively. The work highlights the use of various models and the conditions for its use. This work also put forwards different guidelines for helping to complete the distributed work in a more organised manner. These models are then applied to two organisations to see their impact on the overall performance of teams.

This chapter introduces the various models available for distributing work between a customer site and the delivery/development centre (DC) network. These models are applicable for moving work to onshore/ offshore/ near-shore DCs. However, moving work offshore introduces additional risks that are explained in more detail in Risk Management Guidelines for Distributed Work.

8.2 Distributed Work Approaches

The details about the four model (customer-centric, DC-centric, multi-centre and tailored) is explained below along with a brief overview and the main characteristics of each. Various work models, when to use a particular model and application of each model is also discussed.

8.2.1 Customer-centric Model

With the use of this model the majority of the work is completed at the customer site, and the detailed design, build, and component tests are done at the delivery/development centre.
The customer team transfers the well codified tasks to the delivery centre to be executed with the most discipline and rigor. This distribution model can be used for both onshore and offshore delivery centres and may have to be adapted to suit specific constraints of the project and stakeholders.

Characteristics

- The most basic model, suitable for first time users
- Moderate cost savings
- Moderate risk
- Suitable for all project sizes
- Limits cost savings because only a small portion of the life cycle is completed at the delivery centre
- May not be suitable for development of components that involve a high degree of communication with the customer (e.g., UI, data manipulations, etc.)
- May not be suitable for development of new/complex applications

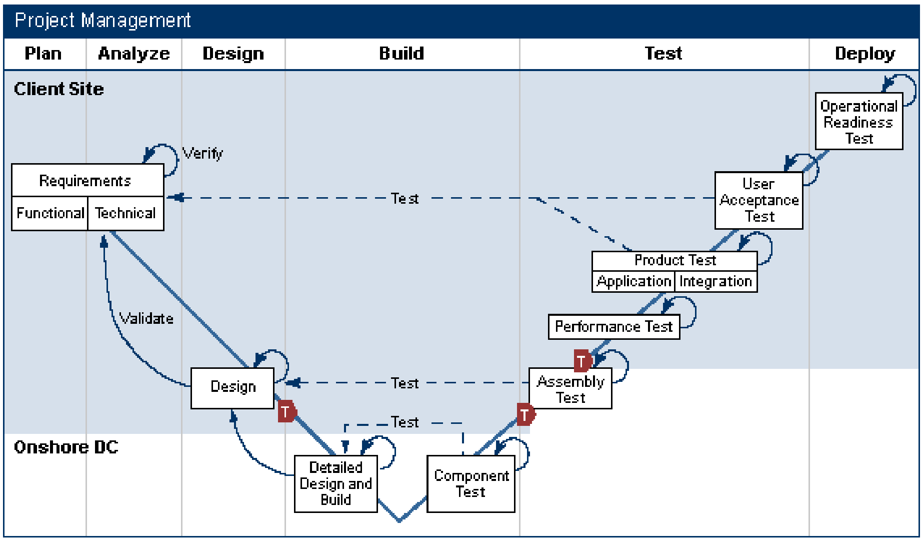

Figure 8.1 Customer-centric Distribution Model

This model represents a minimum amount of risk from the long-distance cross-site communication. The physical distance has less of an effect on communication than significant time zone differences, but Time zone differences can prevent project team members from communicating with each other in real time. Even though this is the most basic distribution work environment, it may still be a perfect model to execute "forever" depending on the stakeholder expectations.

Benefits

- Simple, stable, and repetitive processes. Only a small portion of the development life cycle is executed at the delivery centre. Transition points control the interaction between customer and the delivery centre sites. Also, formal and informal communication ensures a proper flow of information.
- Robust and scalable. The process' simple design gives the delivery centre site these characteristics. This will achieve cost-savings.
- Minimal communication. The delivery centre sites' communication is between the design and build teams and rarely involves the customer. The low amount of communication is

because of the formal and specific design deliverables that are less open to interpretation than requirements.

- Works well with offshore centres. Due to all previously listed characteristics (repeatability, scalability, and robustness); this distribution model works well with offshore centres.

Cross-site liaisons ensure a smooth issue resolution process.

Drawbacks

- Since this model limits the types of tasks which can be done at delivery/ development centres, therefore cost-savings which can be realised are also limited.
- Assembly tests may not be fully conducted at delivery/development centre when an application comprises cross-platform assemblies of components and these components are developed using separate toolsets.

Applications

- This model is particularly desirable for custom-based or packaged solutions that require a pool of skilled programmers producing large-scale applications.
- When planning to work with an offshore centre, use a nearby onshore centre as an intermediary as this will save time and effort during project planning and the project execution phases. Onshore centres should have more application analysis and business skills than their offshore counterparts.
- Impact of required levels of communication.
    - Since this model uses minimum communication with the customer, therefore it may not be suitable to developing the application components that require a high degree of communication with the customer (e.g., UI components, reports, integration etc.).
- This model may not be suitable for developing application components that fit into a new application architecture, as it may require a high-level of communication with the design team. This can be mitigated by having the technical architecture development team at the delivery centre. For developing a new architecture, completing it as "Release 0" at the customer site will reduce the risk.
- Transition of the application back to the onshore team and whether this occurs before or after assembly test (indicated by the red transition points) needs to be carefully considered. Transition prior to assembly test means a change in team and ownership, but may be required due to technical testing constraints (e.g., cross-platform environments) or contractual obligations (e.g., only delivering one part of the application). However, where possible, execution of assembly test is more effectively performed by the development team prior to any significant handover or transition to another organization (e.g., the formal onshore test team).

There are circumstances where even the most basic distribution models cannot be executed and require all tasks to execute at the customer sites. For instance, if the customer is uncomfortable or unwilling to see part of the effort executed at a delivery/development centre or has a particular environment, the delivery centre personnel can work at the customer site.

8.2.2 DC-centric Model

In this model, most of the work is done at the delivery/development centre. The customer site completes only requirements gathering/analysis and user acceptance testing. DC-centric model characteristics include the following:

- Moderate cost savings when applied with an onshore centre
- Significant cost savings when applied with an offshore centre
- Low risks when applied with an onshore centre
- Increased risk with the distance and time zone differences between the customer and delivery centre sites
- Suitable for a wide variety of applications
- Suitable for use with all project sizes
- Requires a higher maturity DC and team experienced with multi-site projects to execute

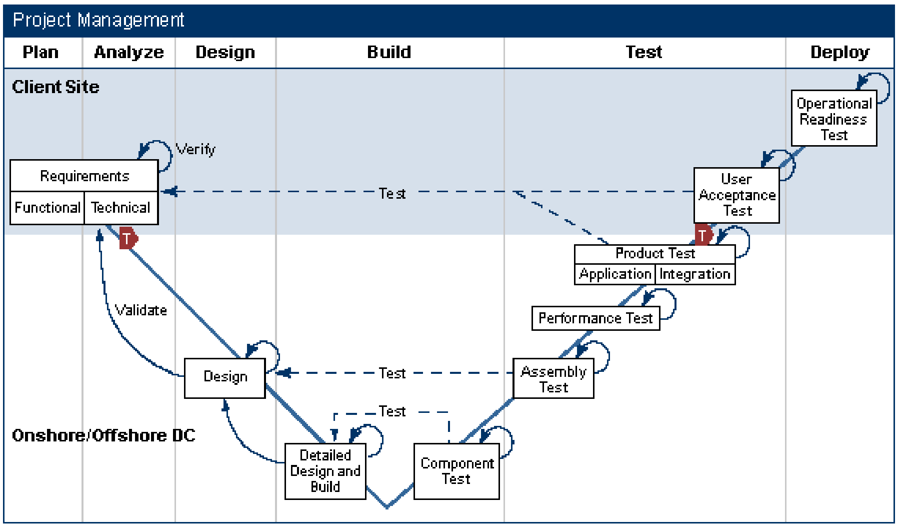

Figure 8.2 DC-centric Distribution Model

DC-centric distribution model enables significant cost-savings at low-to-moderate risk levels because of the task distribution. This is the predominant distribution model used for custom development by the onshore/offshore/near-shore centres today, but may have to be customised to suit specific constraints of the project and stakeholders.

This model can be used only when the customer team is experienced in delivering projects with offshore centres, and the offshore centre is relatively mature (e.g. CMMI Level-2 or higher, Six sigma, etc.) and has demonstrated expertise in the project management, technologies and applications. In order to reduce risk, start the project with a more basic approach, i.e., the

Customer-centric Distribution model, and then progressively migrate additional activities offshore. The desired end-state is best achievable over a period of time.

Characteristics

- This model requires higher levels of communication between the sites than the Customer-centric Distribution model. The key transition point between the sites in this distribution model lies between analysis and design, while in the Customer-centric model focuses between design and detailed design:
  - In a typical situation, Transition Point Overview results in a higher level of communication between the sites because it may involve communication and resolution of issues with the customer and the set-up is less tolerant to delays caused by distance and time zone separation.
  - Application design deliverables are easier to specify than application requirements Transition Point Overview to a sufficient level of detail and without (or with less) ambiguity. This makes the application design deliverables less prone to misinterpretation. Detailed standards exist for specifying the design, while requirements are typically defined more generally and are open to broad interpretation.
- Since this model requires higher levels of communication, it will work well with delivery centres in close time zone proximity to the customer sites. Significant time zone differences will make it difficult for team members to communicate synchronously.
- Engagements based on established offerings and/or assets are particularly well suited to this model, since there are fewer risks related to miscommunication when using stable technologies, environments, and processes.
- This may be the predominant model for working with onshore centres.

Benefits

- This model will enable the realization of maximum cost-savings, as most development tasks are completed at the delivery/ development centre with a more cost-efficient workforce, standard repeatable processes, application-specific methodologies and job aids, reusable assets, etc.
- Since this model was previously used at onshore centres, significant processes, experts, and procedures can be used for the effective management.

Drawbacks

- The distance and time zone differences between the customer and delivery/development centres increases risk.
- This model requires mature (e.g. CMMI, Six Sigma, ISO etc.) and experienced offshore centres to work successfully.

Applications

- Address the risks through various risk mitigation strategies when applying this distribution model with offshore centres:
  - To reduce the communication gap and reduce the rework activities, investment is required communication infrastructure (e.g., internet connectivity, configuration management tools, video conferencing, etc.).
  - Customer can build and invest in the communication technologies at site only if the project is long-term to recover the cost. Otherwise customer can use third party service providers to meet short term goals.
  - An onshore or near-shore centre as an intermediary may be used when using an offshore centre to reduce start-up costs and to reduce the issues related to offshore development.

8.2.3 Tailored Model

With the maturity of customer team and offshore centre, the location of the individual tasks is determined by the cost/benefits/risk analysis. This distribution of tasks at individual levels poses more complexity but it provides optimisation of cost/benefit/risk. The tailored model characteristics are as follows:

- Optimal and balanced in terms of costs, benefits, and risks
- Suitable for all project sizes
- Requires experts and maturity of processes to plan and execute

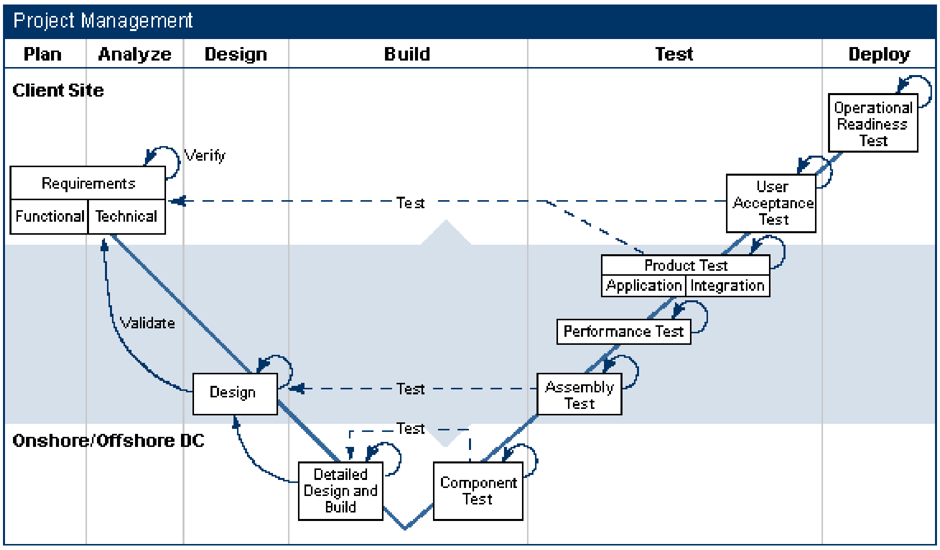

Figure 8.3 Tailored Distribution Model

Creating a Tailored Distribution Model

This method requires experience and help from a delivery centre expert who is familiar with cost-risk-benefits analysis of multi-site development in offshore centres.

The method works with a two-dimensional matrix where functional areas are derived from the application requirements. The horizontal dimension corresponds to the major phases of work, such as analysis, design, component test, etc. The vertical dimension corresponds to the functional areas within the application, such as IPO, Billing, and Account Management.

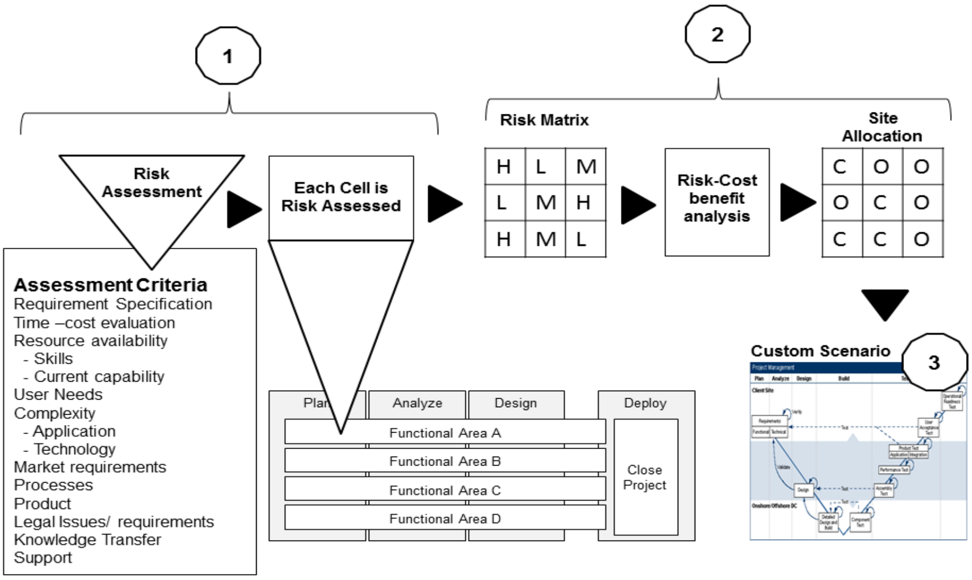

Figure 8.4 Creating a Tailored Distribution Model

There are three major steps in the Tailored model:

- Assess individual criteria for each matrix, and determine the aggregate risk for a given stage/phase of work for a given functional area. The resulting aggregate value of High, Medium, or Low indicates the risk for executing a given stage of work for a given functional area offshore.
- Apply cost-risk-benefit analysis to each matrix cell to determine whether to execute a given stage at the onshore or the offshore centre. Consider factors such as skill availability, cost, potential knowledge transfer, etc. The result of this step is a site assignment matrix, with each cell containing a designation “C” Customer site, "N” Near-shore/onshore centre, or "O” offshore centre.
- The resulting matrix can be used to plan the work/ tasks.

Although the process seems simple and straightforward, it will require experts and maturity to conduct cost-risk-benefits analysis.

8.2.4 Multi-centre Model

In this model, the work is distributed across at least three different sites: the customer site, the onshore/near-shore centre site, and the offshore site. The requirements gathering and analysis and the user acceptance testing are completed at the customer site. The rest of the work is shared between the onshore/near-shore and the offshore centres.

This model is able to provide the benefits of the both the DC-centric and customer-centric models. Greater cost-savings are achieved by using the offshore centre and the risk is reduced because the customer team works closely with onshore/near-shore centre.
The use of this model is on the rise, and it will be a predominant approach in the future, particularly for packaged-based development. Multi-centre model characteristics include the following:

- Combines benefits of the other two models
- Model of choice for packaged-based development

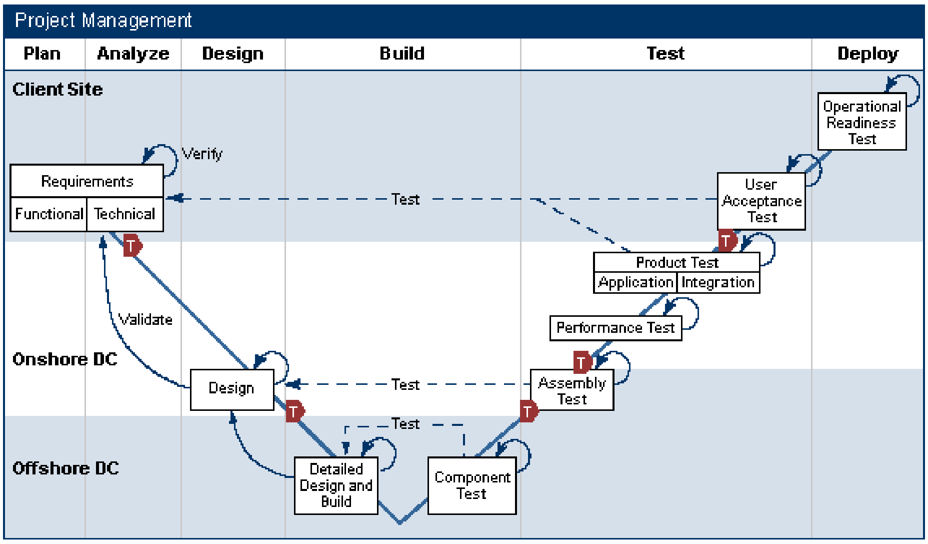

Figure 8.5 Multi-centre Distribution Model

- This model is most suitable for medium and large-scale projects, as it typically involves significant start-up costs (training, infrastructure, and knowledge transfer). However, this model can work for smaller projects if they can use an existing facility or run from the same delivery/development centre.
- This model requires experts and maturity of team. Typically, the customer site team drives the business requirements while the onshore/near-shore centre drives the technical delivery work. The onshore centre also acts as a hub between the customer and the offshore sites.
- This model may not be fully suitable for projects with well-established application and technology architectures because they do not require the onshore/ near-shore centre to act as a liaison between the customer site and the offshore centre. In such a case, DC-Centric model may be more suitable.
- If projects are based on a new architecture, consider a different distribution model. The complexities of dealing with three different sites are magnified by the complexities associated with managing the new architecture development.
- This model is particularly well suited for packaged software delivery:

- The model will work well with moving defined work offshore and keeping more difficult and less defined work onshore/ near-shore.
- Working through an onshore/ near-shore centre also helps overcome language barriers, time zone differences, etc.

Benefits

- Cost savings. This model's scalability can help achieve greater savings for projects with a large build component, while shielding the customer site team from the exposure to the complexities of dealing with remote delivery centres. By using the delivery/development centre to complete more tasks, additional savings can be achieved.
- Lower risk. The risk is lowered as the near-shore/ onshore centre manages the tasks that require higher levels of communication with the customer site team (e.g., UI design, functional design etc.). This mitigates the risk of communication gap and delays.
- Higher quality. The near-shore/ onshore centre ensures the errors are corrected before the customer site receives the build components. The centre does not necessarily inspect the quality, but it will be able to facilitate the transition smoothly.

Drawbacks

- Since it involves significant start-up costs. It also requires an experienced team for execution; this model is suitable only for medium and large projects.

8.3 Distribution Approach versus Maturity/ Experience

The diagram below depicts the relationship between the ability to execute higher complexity distribution approaches and the organizational maturity. The organizational maturity combines two notions:

- Delivery centre maturity. This may be referred as CMMI level rating, Six Sigma, ISO certification etc. attained by the delivery/development centre.
- Customer site team maturity. This is the customer site team's experience with multi-site project execution. This is often reflected in the number (percentage) of the management and development people who previously worked on a multi-site project, involving a delivery/development centre.

The graph of distribution approach vs. experience/maturity follows the S-curve, with use shifting from customer-centric scenario to DC-centric scenario.

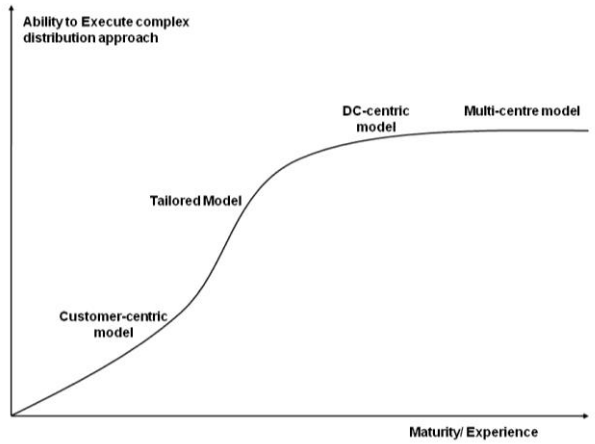

Figure 8.6 Distribution Approach vs. Maturity/ Experience

The implications and considerations for the amount of experience working with a distribution approach include the following:

- The customer teams new to the multi-site may want to start with the customer-centric model.
- The customer team's maturity can be influenced by acquiring people experienced with multi-site development from a delivery centre for the team. Start with the DC-centric model if you have the right people.
- The primary considerations for selecting a specific model are listed in the table. There are situations to execute the customer-centric model long-term, regardless of experience or delivery centre maturity.
- Longer-term engagements must consider the potential for starting with a more basic approach (i.e., the customer-centric model) and incrementally migrating additional activities offshore over time. The desired end-state is achievable only over a period of time.
- Consider if there is potential for a long-term outsourcing arrangement at an offshore centre at the end of the delivery (i.e., a Design, Build, Execute arrangement). In such a case, the DC-centric model provides an additional advantage because there is no need for knowledge transfer to the customer personnel.

8.4 Model Refinement

The basic models are rarely applied on projects in their pure form. Instead, the engagement planner and managers usually refine the models based on specific aspects associated with their situations. The refinement process involves determining the best location for a given task. For example, in the customer-centric model, the assembly or product tests can move from the customer site to the offshore centre site. Moving the assembly test to the offshore centre may be beneficial. Keeping all or a portion of the assembly test will result in removing more errors from the coded work units before they are transferred to the onshore centre or customer site. Apply this fine-tuning process to all development tasks that lie on the border between the sites (e.g., application design). When considering moving a development task from its designated location in the model, consider risk mitigation strategies to address negative impacts of the move.

Apply the appropriate risk assessment criteria when deciding alternative locations for a given task. In general, the lower the aggregate risk results from looking across multiple risk factors, the more appropriate a given task is for execution at an offshore centre.

8.5 Delivery Centre Organisation Structure

This work further explores the management structure, arrangement/contract, and staffing/organization required for completing the project successfully. The management and organisation structure has to be selected dependent on the distributed work model for successful and efficient development and delivery of the solution/ project.

There are two key aspects of the relationship between the customer and the delivery centre teams that set apart different Delivery Centre (DC) organisation approach:

- Extent of integration between the teams, i.e., the extent to which the DC personnel are engaged/used in the project's organization and the communication requirements between the customer site and the DC personnel.
- How much and which of the DC's methodology, processes, knowledge, tools, and technical facilities are used by the project?

The above two aspects influence the organisation structure of teams at customer and offshore centre sites:

- Communication: who is in control and communication and command lines
- Contractual/ Service Level Arrangements: what is sub-contracted and the arrangement details
- Recruitment/process: project staffing, process to follow

There are four different organisation structures which have been applied successfully in different areas. These approaches may not be applied in isolation as some practices are shared across and the boundaries are not rigid for successful completion of projects.

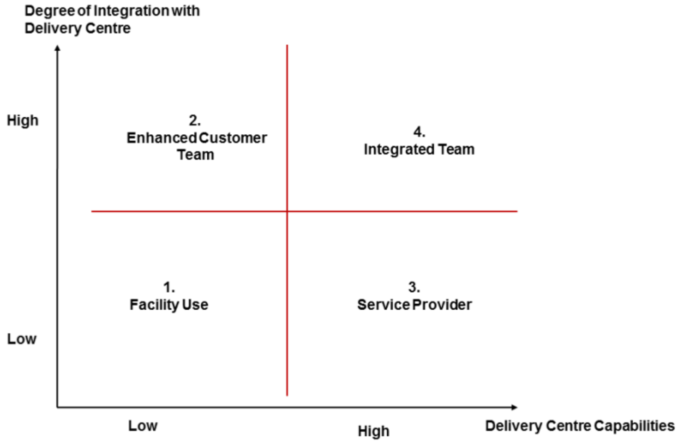

Figure 8.7 Organisation structures

8.6 Facility Use

With this structure in place, the main aim of the customer is to get the office space from a DC on rent or lease along with the basic facilities such as desks, telephones, computers, shared file services, and connectivity to the customer site. This type of arrangement is more useful in the following circumstances:

- Projects which need to ramp-up quickly, which may be due to the following situations:
  - A project having short time to market and the customer does not have time for building infrastructure or recruit staff quickly.
  - Customers who do not have enough IT development space currently available in-house.
- Small projects which cannot afford higher cost of initial set-up in terms of both time and expense.

This organisation method has the following characteristics:

- Set up is easier and quick
- Influenced by the availability of infrastructure at the DC
- Capabilities of DCs are less used
- Little communication/ integration between DCs and customer
- This is not suitable when the distances between customer and offshore centre is large

8.7 Enhanced Customer Team

This organisation method is used when the customer wants to enhance its capabilities by using the offshore resources in order to reduce the skills gap.

This organisation method has the following characteristics:

- Set up is easier and quick
- This is not suitable when the distances between customer and offshore centre is large (e.g., US with Philippines etc.)
- Capabilities of DCs are less used

- Higher level of communication/ integration between customer and DC
- Projects that will need a substantial number of skilled personnel at customer site and can be hired from DCs.
- The facilities and tools are not available at DCs.

8.8 Service Provider

This organisation structure is can be defined as two teams, the customer site team and the DC team, working together in a highly collaborative manner. The work is subcontracted to the DCs with set of service level agreements and is managed with an established communication process. This type of arrangement is more useful in the following circumstances:

- A task is subcontracted to the DC, and the communication between the customer and DC is managed through a set of well-defined entry/ exit criterion.
- Generally projects/ customer will adopt fixed-fee costing method for this kind of structure.
- There is more freedom to DCs to allocate and manage the resources.
- The communication process will change as per the complexity of the project.
- This method requires clear defining of the accountability and delivery parameters.
- Demand process should be clearly defined in order to use the resources in an optimised manner.
- The customer will have relatively low start-up cost of contracting with the DC team as the DCs are using already existing methodology, training, and infrastructure.

Typical Use

- Projects that want to maximize the leverage of the DC capabilities and can work within the constraints of proven offerings, a known environment, and stable architectures. For example, an ERP project based on a well-understood offering (e.g., Oracle) with a stable platform, where a set of modules needs to be coded.
- Projects that anticipate their needs may expand rapidly in the future and need a choice of DCs that can accommodate their requirements. For example, consider an SAP engagement in which demand rapidly surged, and it had contracts with three DCs to satisfy its capacity needs.

This organisation method has the following characteristics:

- Works well on projects with established application/technical architecture and with well-established and documented standards for specifying design deliverables (commodity market)
- Works well with offshore DCs
- Works well with established, mature offerings
- Works well in a fixed-fee arrangement to reduce risk of the customer site team
- Relatively low start-up costs

- Light-to-medium interaction between the customer site and DC teams
- High in leveraging the DC capabilities as the DC optimizes the use of its team and other resources
- To mitigate risks, mixing customer site and DC personnel is necessary and site liaisons could be a good option.

8.9 Integrated Team Approach

The project structure is similar to that of a general commitment, except that the project team is distributed among multiple sites. The project achieves significant cost savings by:

- Utilising the DC procedures, processes, tools, and infrastructure.
- Using the DC skills and resources by filling key technical and managerial roles with the DC personnel, and by integrating a critical mass of the DC personnel.
- Setting up accountability, which is less of an issue in this approach since the project is managed as one integrated team.

Typical Use

The project may have customer-facing or functional skills, but:

- It needs the DC for technical delivery capacity/expertise, e.g., the customer site team sold the work, but needs to assemble a team quickly to deliver the technical piece.
- The project relies on the DC to provide a significant portion or all of the technical delivery methodology, approach, estimating, etc.
- The project relies on the DC to fill some management and/or team lead spots.
- The project team in the DC operates as a virtual extension of the customer site team, with a fully mixed and integrated team of the customer team and the DC personnel.

Characteristics

- The DC team tends to drive many of the technical and project management approaches.
- This approach tends to have higher set-up costs.
- This approach supports projects that are in-flight, i.e., projects that started as traditional single-site projects and then become a multi-site project working with a DC. This is because this teaming approach accommodates knowledge transfer, which is part of the transition to multi-site process.
- It has the highest degree of integration between the customer and DC personnel.
- It achieves the highest leverage of the DC capabilities. It overcomes the Service Provider approach limitation by working well for projects that are based on new and existing application/technical architectures.

8.9.1 Choosing a Teaming Approach

Choosing the teaming approach involves assessing engagement requirements and examining a variety of factors. Some of these factors are listed below:

Table 8.1 Teaming Approach

Issue/Factor	**Facility Use**	**Augmented Customer Team**	**Service Provider**	**Integrated Team**	**Comment**
Quick/ fast Scalability	Suitable	Suitable	Depends on availability	Not suitable	The Integrated Team approach does not work for fast scalability because of the set-up costs/effort.
New Architecture	Questionable	Suitable	Not suitable	Suitable	Since a new architecture requires a high degree of interaction with the customer and the customer team, hence Service Provider type of interaction is not suitable.
Work-in-progress projects	Suitable	Suitable	Questionable	Suitable	Work-in-progress projects require knowledge transfer, so Service Provider approach is not appropriate.
Short time-to-market	Suitable	Suitable	Suitable	Suitable	If the project length is less e.g. 3 months or so, and an offshore centre is to be involved, then Integrated Team approach may not be suitable.
More knowledge transfer	N/A	Suitable	Not Suitable	Suitable	If higher knowledge transfer is required, then service provider approach is not suitable.

8.10 Processes & Procedures for Onshore/ Offshore/ Near-shore work

The distributed onshore/offshore/ near-shore work arrangements require a number of steps to be completed. These are very much different from the traditional project management at one site. Therefore, organisations need to create a set of processes, procedures, tools, and techniques so that the distributed work can be managed effectively and efficiently. This helps organisations to manage and share the work across locations with a standard set of rules and processes. This ensures consistency and reusability of the resources/ documents and deliverables across projects.

Organisations can also get certifications like CMMI/ Six-Sigma or any other standard methodology for their processes, procedures, tools, and techniques. This is highly important to build confidence of customers in the delivery of projects on time and on budget.

8.11 Managing Transitions across phases/ multiple sites

Transition of project across multiple sites requires different set of processes, procedures, tools and techniques. The traditional transition processes of moving from analysis to design to build stages etc. may not be fully applicable. Therefore, organisation needs to define its new set of processes to manage the work/ project effectively.

Organisation must consider the following issues to prepare the plan and manage the work:

- What is the best possible and optimum way of transfer of knowledge from one site to another
- Monitoring and Controlling process
- Dry run of the project
- Managing risks
- Approval of the transition process by the stakeholders
- Prepare checklists for various stages of the project
- Prepare contingency plan
- Skills-gap analysis for resources

Keeping in mind the above issues, the following are some of the effective techniques to manage the transfer of the project to the development centre.

- Process for Knowledge transfer: Organisation must use a good process to transfer the knowledge from one site to another and this has to be measured against baselines to make it efficient.
- Managing with Checklists: Checklists are created for various modules, deliverables, documents, hardware, software, databases, resources and skills. These are very effective in controlling and seeing the progress of the project.
- Dry run/ pilot run: Project is given a dry run for a few set of data to see that the overall objectives are met and project is behaving as per the expectations before the final release and go-live.
- Reduce communication gap: Do regular secure information sharing with stakeholders. During transition, see the possibility of having key users working at development centre.

8.12 Configuration Management (CM)

In the multi-site environment, the most affected area is configuration control. Organisation must create set of processes, procedures, tools and techniques to manage the integrity of the project across sites and ensure various stages are completed as per the plan.

The repository for the configuration management must be able to provide service to all the sites with ease and flexibility and also adhering to the various security concerns.

Organisation has to consider following questions:

- Has the CM plan/approach been defined?
- Has the change process been defined and approved?
- Has the CM effort been estimated and budgeted?
- Is there involvement of resources from the delivery centre?
- Have you identified roles for CM support activities?
- Have you signed an agreement/SLA with the delivery centre for CM support?
- Has ownership for all files/objects been assigned?
- Has long-term ownership of the CM repository been resolved?
- Have contingency and roll-back plans been established in case the repositories get out of synch?
- Have plans for CM audits been addressed in the CM plan, and are they covered by the CM budget?
- Are there plans to test the CM repository from all remote locations to ensure that accessibility and performance requirements are met?
- Approval of CM plan by stakeholders.
- Connectivity issues: The connection speed, bandwidth, and cost influence where the repository can be located and which CM tools to be used. Various options are VPN, Leased line, Company-WAN, etc.
- Where would the repository be located?

Three approaches for organizing a CM repository are identified as best practices: centralized, independent repositories, and multi-site with replication. These approaches differ from each other in terms of performance, flexibility, and cost.

Centralised Repository: This offers high flexibility, easy set-up and operate, easier regulation and compliance due to single site but its performance is dependent on the connectivity.

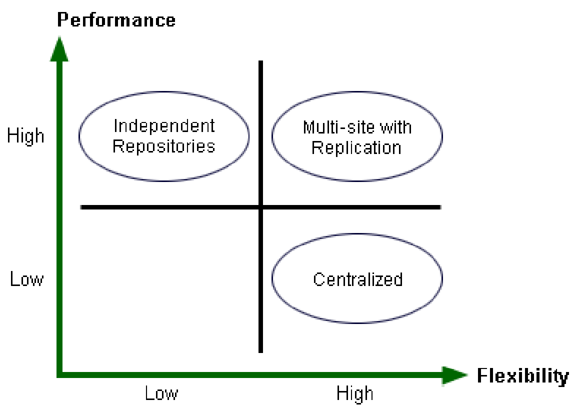

Figure 8.8 Potential Repository Locations

Independent repositories: Low Flexibility, medium set-up complexity, high performance as individual site has its own CM tools, files are synchronised manually.
Multi-site with replication: High performance, Higher flexibility, but with higher set-up costs, requiring high-speed and bandwidth connection

- What are the various CM Tools?
- Availability
- Number of sites
- Project Size and complexity

8.13 Estimation Process

Estimation process is difficult for the distributed work, as the number of parameters is more due to the involvement of multi sites. Significant effort has to be put into arriving at the estimate of time and cost for completion of the project. Development centre must be involved in the estimation process in order to minimise the risk. Organisation must take into account the followings issues:

- Has the estimation for time, effort and cost been done and approved by appropriate stakeholders?
- Have you created service level agreement and approved by stakeholders?
- Have you planned for time and budget for training of offshore resources?
- What is the plan for knowledge transfer and budget as well as time frame for the same?
- Have the estimates considered risk factors such as lack of communication, cultural issues, resource availability, and technology differences, etc., which are common in multi-site development? What kind of buffer is available?
- What is the contingency plan?
- Are all key areas covered in the estimates: analysis, design, build, test, etc.?
- Is the cost for monitoring and controlling also be estimated?
- Have you involved all stakeholders, technical and functional, to assist the estimating?
- Have you allocated budgets across organizations/locations and assigned responsibilities for deliverables?
- What are the expenses for travel, communication between sites, etc.?
- For costing the project, have you involved the delivery centre experts in providing rate, tax, multi-year inflation adjustments, etc. into the cost calculations?
- Have you considered any pre-existing master services agreement conditions that you may already have with the customer in terms of pricing this new deal?
- Have you accounted for currency and inflation risks (expenses will be through local currency)?

8.14 Intercultural Guidelines for Distributed Work

It is crucial for today's business personnel to understand the impact of cross cultural differences on business, trade and internal company organisation. The success or failure of a company, venture, merger or acquisition is essentially in the hands of people. If these people are not cross culturally aware then misunderstandings, offence and a breakdown in communication can occur.

The need for greater cross cultural awareness is heightened in the global economies. Cross cultural differences in matters such as language, etiquette, non-verbal communication, norms and values can, do and will lead to cross cultural blunders.
U.S. and British negotiators found themselves at a standstill when the American company proposed that they "table" particular key points. In the U.S. "Tabling a motion" means to not discuss it, while the same phrase in Great Britain means to "bring it to the table for discussion."

Cultural awareness is crucial for any development project involving multiple countries or workforces. Differences in culture can affect team communication and influence team processes. This has always been an aspect of project work, and will become increasingly prevalent as more and more projects use multiple development sites and local and global workforces.

It is important to value the diversity of people and practices across the world. The company's underlying code of ethics and positive support of people through company-wide programs are key pillars of running any successful engagement.

Organisations should consider the following issues for effective communications across different countries and cultures:

- Increasing cultural awareness
- Identifying a communication strategy to overcome language barriers
- Encouraging team work
- Providing opportunities for face-to-face interactions
- Using effective virtual teaming tools
- Addressing country-specific business hours and holidays
- Groups vs. individual orientation
- Hierarchy and status
- Risk taking ability
- Communication Style – Direct/ Indirect
- Task vs. relationship
- Short term vs. long term
- Use of implicit and explicit messages

- Tolerance for ambiguity
- Responses to problems
  - Use of silence for showing respect vs. asking questions up-front
  - The desire to please others vs. the desire to identify issues.
- The desire to preserve other people's dignity and self-respect.
- Different emphasis on time.
- The desire for perfection.
- A strong social network.
- A strong work ethic.

8.14.1 Common Expectations

Language skills are a key part of working across geographies, and English is often the most common business language used. Accents may initially cause a few issues.

If there is a language barrier, identify a communication strategy to overcome it.

- Identify leaders with good language skills as key contacts and include them on all project status calls.
- Some people have good language skills, but may not be as confident as others. Some, who may feel less comfortable in the multicultural work environment, are likely to be more timid in discussions. During meetings, explicitly invite them to speak their thoughts and opinions.

In general, multi-site projects use extensive written communications to minimize misunderstanding verbal messages. Instant messaging tools can be an effective substitute for telephone conversations in circumstances like this. Some cultures are not accustomed to writing in English at the volume that projects require, so use a combination of written and verbal communication that makes sense to the overall project team.

Organisation should consider the following questions for improving cross cultural awareness:

- Be aware of your own culture. What is your communication, decision making, and issue management style?
- Did you learn about the culture of global colleagues?
- What are the plans to raise cultural awareness across the project team?
- Are you aware of the potential cultural differences that affect your project's communication, decision making, and issue management?
- How will you respond to these cultural differences as a project and as an individual?
- What plans do you have to promote collaboration and communication?
- Have you communicated these plans to both the customer (local) site and the global teams?

- Have you trained both the customer site and global teams to use the virtual teaming tools effectively?
- Have you met the teams from the different geographies?
- How will you measure that your multi-country and/or multi-workforce project team is communicating effectively?

8.15 Issue/ Problem Management

Issue/problem management involves the process for identification, analysis, resolution, reporting, and escalation of the project's issues and problems. There has to be clear documentation of how and with which parameters issues are prioritized, assigned, communicated, viewed, escalated, and resolved.

With multiple sites and lesser face to face communication, resolving issues and problems is more difficult. Therefore, teams at different sites will have to rely on a common process and/or an automated tool to track, share, and resolve issues/problems in a timely manner.

Organisation should consider the following parameters for managing the issues effectively and efficiently:

- Plan issue/problem management.
    - Define the issue/problem management objectives and goals.
    - Define the issue/problem management process. Include escalation procedures.
    - Identify issue/problem management roles.
    - Identify issue/problem management tools.
    - Finalize issue/problem management plan. Ensure all sites understand and agree to the plan.
- Execute issue/problem management processes.
    - Identify issues/problems.
    - Track issues/problems.
    - Assess issues/problems.
    - Develop issue/problem resolution.
    - Monitor and communicate on issues/problems.
    - Report metrics.

Organisation should consider the following questions:

- Is an issue and problem management process established?
- Have you selected issue/problem management tool(s)? What is the installation/roll-out plan for the tool(s)?
- Are issue/problem management roles defined and assigned?
- Are issue/problem documentation standards defined?

- Has an escalation process been established?
- Have you developed a plan for communicating issues/problems to team members and the customer?
- Does training exist for those who use the issue/problem management tool(s) and processes?
- Were metrics created to measure the effectiveness of the issue/problem management process?
- Have you done a causal analysis of the issues at defined milestones?

8.16 Resource Management and Organisation Design

Understanding Organisation design is very important so that various challenges of current capability assessment, enterprise environmental factors like work, culture, management style, etc. can be addressed for organising a distributed project team, define project roles, and manage the resources. This will help stakeholders estimate the work effort, and plan for the work, and efficient use of resources and communicate clearly the roles and responsibilities.

In order to manage the distributed effectively and efficiently, stakeholders form all areas must be involved in planning, and build team behaviour and not Offshore vs. onshore team /client team.

Approach

Organisation structure and design could be as follows:

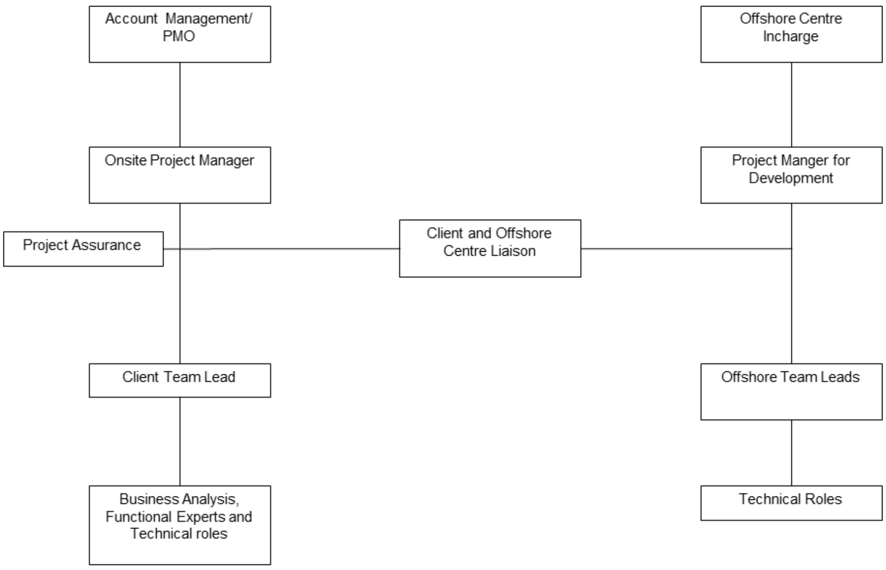

Figure 8.9 Standard Organization Structure

- Account Management/ Program Management Office takes care of the all the projects being developed with customer. This is required to care of business requirements and customer stakeholder expectation management.
- Offshore Centre In-charge is responsible for all the projects running at the centre.
- Onsite Project manager takes care of the full project, managing schedules, budgets, project execution, monitoring and controlling. Project Manager communicates all the project progress to all the stakeholders directly and through Client and Offshore Centre Liaison. Project Assurance manages and communicates the status of the project to all stakeholders and monitors the project risk and escalates the risk/ issues as required.
- Offshore Centre manager for Development is responsible for managing the work at offshore centre and also provide status report to the onsite project manager.
- Client and Offshore Centre Liaison is to improve the communication between the onsite and offshore centre and provide information to all stakeholders to minimise the risk.
- Team leads at individual sites manages their respective teams for performing various business, functional and technical roles to complete the project as per the plan and manage the resources efficiently and effectively.

In addition to making organization and staffing of the project more complex, multiple sites also makes managing the resources more complicated than with traditional, one-site projects.

Project manager and stakeholders must take care of the following:

- Leverage delivery centre resources as much as possible when staffing projects to take advantage of the deep application and technical skills and cost savings. Engage delivery centres early to secure resources.
- Subject matter experts (SMEs) are needed from the DC to help define and refine the estimates and work plans.
- Each centre is different from other in the staffing model, resource management, processes and procedures. Work closely with delivery centre liaisons so that right skills people can be identified quickly. This will help you avoid delays in obtaining resources. Understand the delivery centre's demand management processes so that necessary lead times can be accounted for in the project schedule.
- The cost structure associated with delivery centre resources varies.
- Liaisons can help you to find resources and guide through the complexities of identifying and procuring offshore resources in a manner that complies with company and national labour policies – for example, visa, wages and expenses, and tax considerations.
- UK work permit process is different from the USA and also the time required is different. Visa lead times vary by country of application (India vs. China) and by cities within a country (Bangalore vs. Mumbai). Visa lead times also vary by visa type (H, L, etc.). The lead-times vary over time as per new government legislations from time to time.

- Discuss about the management style: dual management or not; long-term planning for resources, fully utilising the resources from offshore centre, etc.
- Is the project to be released in multiple stages? What are the plans for multiple releases?
- How will you take care of attrition of skilled resources?
- Roles and responsibilities are clearly defined for each team member including owner, reviewer, and approver of the various deliverables and milestones in each stage. Consider bringing offshore resources onshore and vice versa for better understanding and also transition of work/ tasks.
- To break cultural barriers, involve people from different teams and form virtual sub groups.
- Treat each member equally even though their parent organisation policies may be different e.g. vacation and holidays, working hours, overtime, and flexible work hour policies.

The following points may be considered for an effective organisation design and resource management in distributed environment:

- Have all stakeholders (customer site, delivery centres, users, 3rd party vendors, etc.) been considered, when defining the organization design and resource needs?
- Consider involving client for organisation design and resourcing needs.
- Early notification to the delivery centre resourcing personnel during the selling process to tell them that a deal is under progress in which they may be involved?
- Involvement of subject matter experts from all sides for proposal, estimating, and planning of the project.
- Has an organization design and hierarchical structure been defined and approved by all the stakeholders?
- Is there roles and responsibility document and matrix? Does everyone agrees and approves it?
- How will the third parties be integrated? What are their roles and responsibilities and deliverables?
- What are the communication processes and requirements for the current project?
- Is the offshore centre being used for only for application and technical skills? What will be the cost savings?
- Does the project need contract staff for filling in the skills gap?
- Does the project management overlaps with other projects?
- From the project requirements and scope, pan effectively and efficiently for the future demand of resources.
- Consider the appraisal process and career progression path of the offshore resources. This should be managed as per the needs of the centre.

8.17 Summary

This chapter describes various frameworks and methodologies which can be used for successfully managing projects in the globally distributed environment. The criterion and conditions for use of various models, organisation of work in the distributed projects is also given for delivering the projects efficiently and effectively in the global organisations. The chapter discusses the approaches for distribution of work, risk and management, cross cultural issues and management, virtual communications, team and organisation approaches in the managing and delivering globally distributed projects, teams and clients. These models would provide the better structure and flow of the work and resources in global scenarios for delivering projects effectively and efficiently.

9. CASE STUDY

In this chapter, the research is applied in the case study of AML for a building society, identifying how the formalisation would be able to facilitate projects. The case study demonstrates how these models are populated; and how this checking the consistency for the models. Project is studied/ analysed to demonstrate conformance to PMBOK standard and Fit/Gap Analysis is done to analyse the errors/ gaps/ shortcomings in the methods used. The created models, tools, deliverables, and frameworks could be available for reuse.

The case study on Anti Money Laundering is the real case study. The case study was chosen due to the following reasons:

- The organisation was willing to participate in the work
- The organisation wanted to improve its project management processes for improving their project deliveries
- The project was a large complex project with onshore-offshore distributed development
- The project could provide information for various areas of PMBOK standard processes
- Interactions with PM, Stakeholder designations

The following documents were created during the case study:

- Project Plan using various dependencies and constraints
- Project Closure documents i.e. UAT sign-offs, and Lesson Learned Log
- The fit gap analysis for Project Execution Process Group and Project Closing Process group

The case study being considered is discussed as follows:

9.1 Anti-Money Laundering Solution:

Develop, deliver, and implement the Anti-Money Laundering solution in one of the UK building society. The following were the stages of the projects:

- Initiation and Kick-off onsite
- Business analysis onsite
- Engagement and Project Management onsite
- Customisation, Design, Build and QA Test at the offshore development centre
- Implementation, UAT, user training, and sign-off onsite
- Post implementation offshore

The project was to implement an Anti-Money Laundering (AML) Solution at low cost for one of the financial institutions. The above processes are applied for managing the project effectively and efficiently.

As a purpose-built solution for institutions seeking an efficient, scalable and comprehensive solution for all aspects of AML compliance, Institutions can choose from the following modules:

- Customer Account opening due diligence and Mandatory Information management
- Black List/ Watch List monitoring
- Link Analysis uncovering suspicious networks and associations
- Risk Scoring and Customer Profiling
- Suspicious activity monitoring
- Case management
- Legal investigation tracking
- Regulatory reporting

AML monitors financial transactions (both cash and non-cash), and alerts financial institutions of any suspicious activity. Once alerts have been generated, a step-by-step workflow with built-in case management guides users through investigation, case tracking and reporting within one fully-integrated environment.

AML caters to:

- Banks/ Building societies
- Insurance companies
- Securities broker-dealers
- Money transmitters
- Asset Management companies
- Factoring companies

Customer Due Diligence is an important facet of risk identification and assessment in an AML program to deter miscreants from entering the financial system. AML provides tools such as:

- List Screening to determine if an applicant is among the ranks of known terrorists, its identification information will be compared against government lists of terrorists, such as those issued by the Office of Foreign Assets Control (OFAC) and the United Nations (UN), list of Non-Cooperative Countries and Territories (FATF-NCCT), and Politically Exposed Persons (PEPs). It supports both published lists or the Black lists and internal control lists termed as Watch lists.
- Know Your Customer (KYC) Compliance Scores to monitor the levels of regulatory adherence. This helps in updating the KYC levels of existing customers and serves as a handy audit tool.
- Duplicate checks to fish out undisclosed multiple accounts. This may relate to the same or multiple products or locations and is very useful when there are multiple source systems.
- Link Tracer and Grouping for identifying hidden relationships between customers so as to enable enhanced monitoring over a group of people who appear to be connected or acting in concert.

AML is a powerful tool for identifying possible high-risk relationships to uncover complex money laundering operations. Link Tracer follows three fundamental steps:

1. Business Defined Relationships: Reference data, such as common customer identifiers and household indicators, is used to identify permanent relationships between underlying accounts.
2. Reference Data Relationships: If money launderers attempt to disguise their behaviour by making changes to name, address, and reference details when opening accounts, the system can identify links on other reference data elements to generate important association information in notifications and reports.
3. Transaction Relationships: When money launderers spread their activity across multiple accounts, the system is capable of identifying possible associations through transaction patterns between accounts.

Results of the analysis are displayed as a graph of linked objects supporting drill-down operations. The Graphical Link Tracer facilitates better understanding of the hidden structure of investigated data, and helps to quickly identify relationships among individual accounts, people, and organizations. Used effectively link analysis provides reliable indications of fraud and money laundering activity.

Besides obtaining and verifying above information, AML helps in Record keeping of the information used to verify identity for required period of time after the business relationship has ended.

AML is a J2EE compliant application. Built upon, open standards; it can be easily and economically maneuvered to meet the changing technologies in the financial and banking sector. It allows clients to easily migrate across various Application Servers, Databases and Legacy Core Banking or Total Branch Automation System interactions with minimal impact on the core product.

9.1.1 AML Project Activities

The following high-level process was followed for the Project:

The functional and technical requirements of the solution were captured and the high-level process to do that was as follows:

Functional:

- ✓ AML Base Product Demonstration
- ✓ ABC Building Society AML current process
- ✓ Process – Solution Mapping
  - ▪ Current Processes & Reports
  - ▪ Gap analysis
- ✓ Documentation of Gap Analysis findings

Technical

- ✓ Mapping of Data Structures: AML & AS/400
  - ▪ Additional data structures added in existing document
- ✓ Feasibility Analysis – 3rd Party Systems

- ✓ Documentation of Data Requirements
- ✓ Hardware Recommendation
- ✓ Deployment Procedures

The sign-off was achieved and the following functionality documents were reviewed and signed-off:

Documents Reviewed:

- ✓ AML Base Product Functionality Document
- ✓ Functional Specifications Document
- ✓ Data Requirements Document
- ✓ Interface Specifications Document

The activities which were planned and followed for the project management of AML solution are shown in the Fig. 9.1

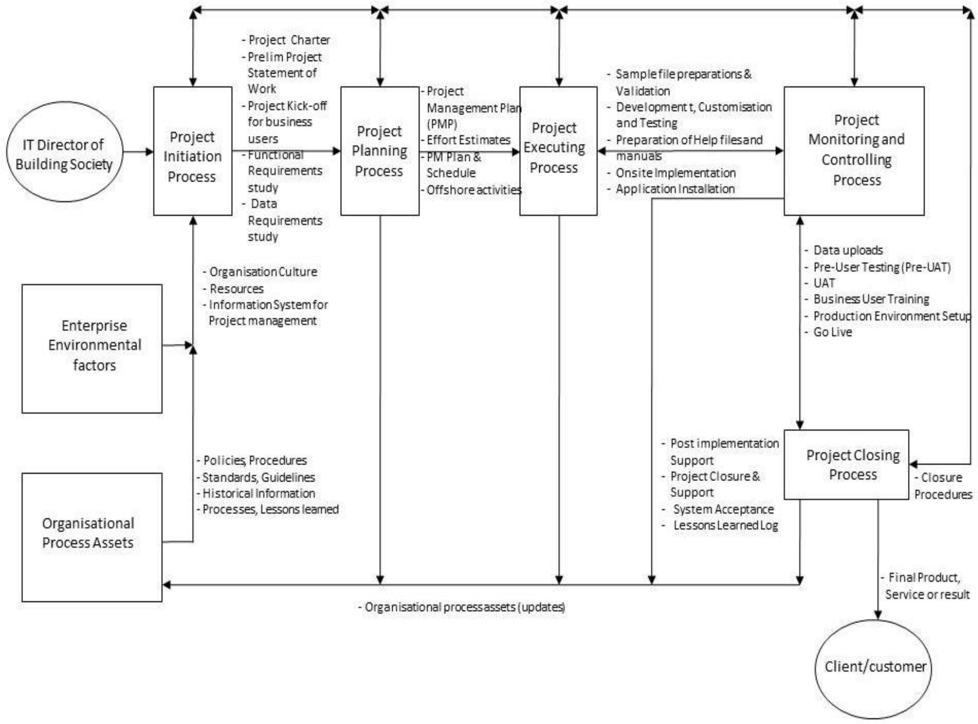

Figure 9.1 AML Project Activities

The above plan was implemented as per the project high level project Gantt chart shown in Fig. 9.2 The business analysis team was brought onsite for gathering various requirements that is high-level, application, product requirements, technical architecture and defining the final scope of the solution. The team was managed by the project manager with the author supporting various activities on the project.

9.1.2 AML Project Timeline

The team conducted the business analysis study onsite. All the business requirements, scope, testing scenarios, and stakeholders for various stage of the project were captured and documented. The business requirements also highlighted the raw data for testing, test sites, UAT plans. The web services and managed interface were captured for the data to be placed for performing AML activities and conduct the various analysis based on regulatory and compliance rules of the UK and the building society.

The project schedule for any AML project looks follows standard PMI processes from initiation to closure of the project and is shown in Fig 9.2

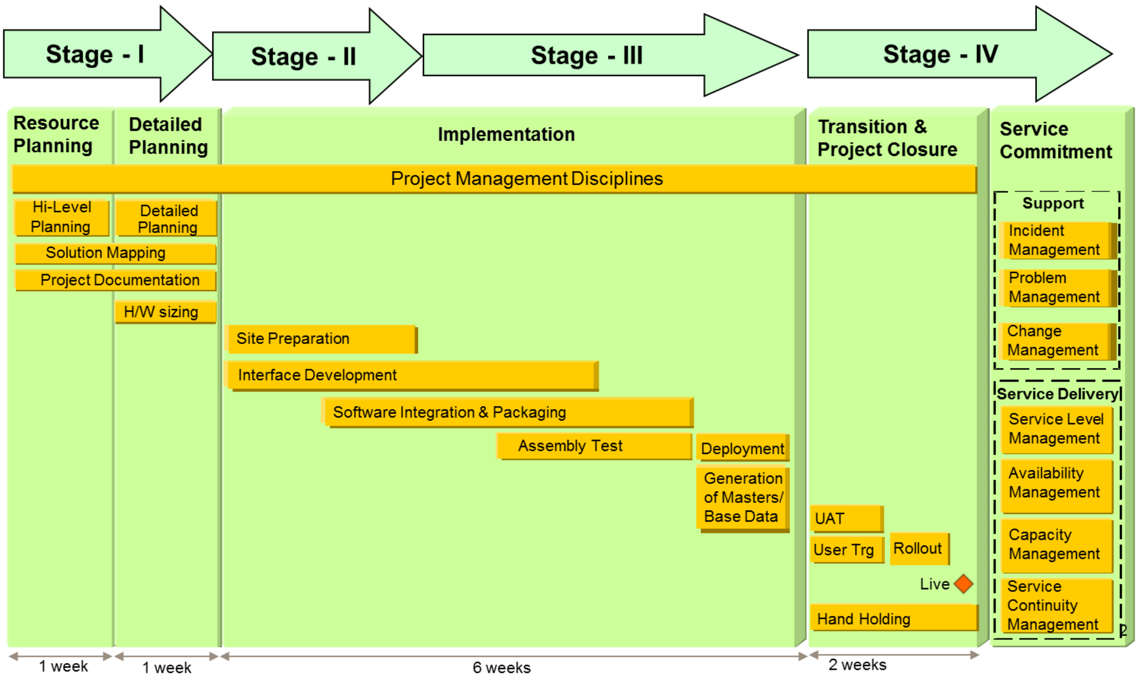

Figure 9.2 Project Schedules

The organisation structure for the solution supplier Project Manager onsite and Product team offshore alignment was agreed upon for the AML project management and delivery. This enabled the single point of contact from the supplier side for any communication and resolutions. The structure was as shown in the Fig 9.3:

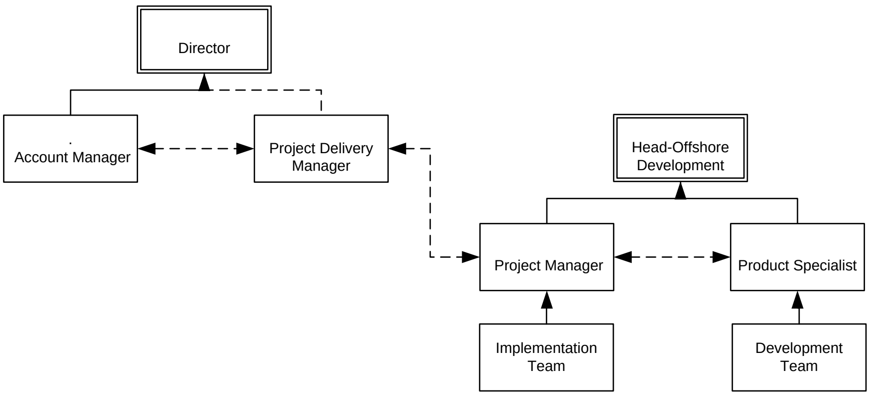

Figure 9.3 Supplier Project Team organisation

The client/ customer team was established to manage the project, requirements and communications from the client side. This was a good step so that there is single point of contact for the client side for all the project related communications and resolutions. The client project team structure is shown in the Fig. 9.4:

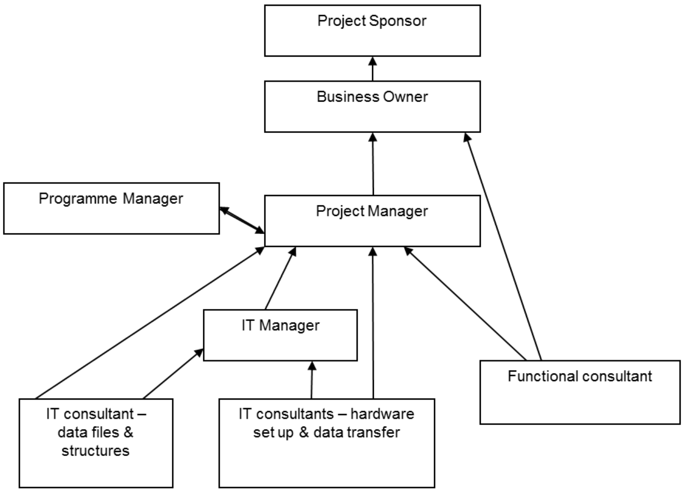

Figure 9.4 Client Project team organisation

The project was focussed on the following high level delivery plan:

- ✓ Application delivery with Customization
- ✓ User Acceptance
- ✓ Go-Live
- ✓ Project Closure

The meetings for the execution of the project, project monitoring and controlling were planned as follows:

- ✓ Weekly update
  - Project Status Report (PSR) - Friday end of day (PMs and other senior stakeholders)
  - Conference calls - Monday 10:30 AM UK Time (PM teams)
- ✓ Steering Committee (SC) meeting (PMs and other senior stakeholders)
  - Monthly Progress Report (prior to SC meeting)
  - Conference Call / Face to face / Hybrid
  - Last Monday of every month

Project plan was prepared based on the scope, requirements, customisations in Microsoft project for project execution, monitoring and control for both onshore and offshore teams. RAID logs were created to proactively manage the risks, issues, assumptions, and dependencies.

The MSP plan is given in the Fig 9.5:

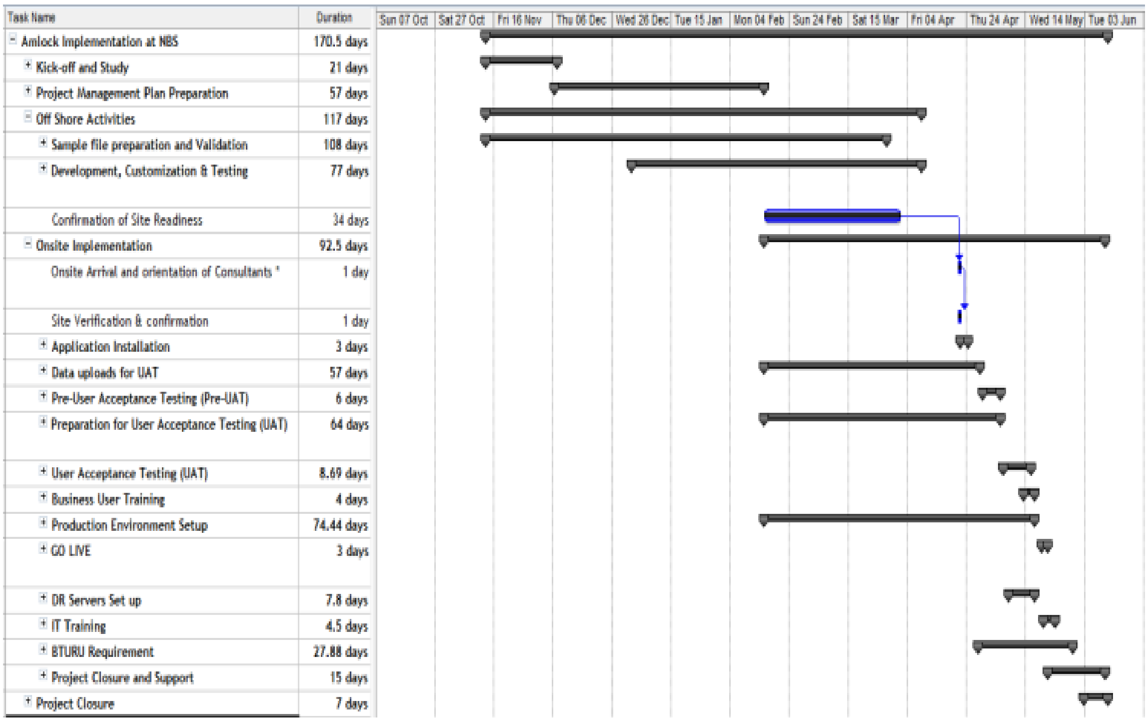

Figure 9.5 Project Timelines

The team went offshore and started customising the solution as per the business requirements gathered and developing new modules. The team was managed by the programme manager from UK and onsite project manager and technical architect. Weekly status meetings were planned with all the stakeholders who were responsible for execution of the project. Status reports were sent to all the business sponsors and stakeholders to apprise them of the progress of the project and highlighting various key deliverables and milestones achieved, and also forecasting possible risks and preventive or corrective actions taken.

The product team customisation was led by the product specialist and the single point of contact was implementation manager from offshore who worked for the programme manager from UK.

9.1.3 AML Processes and Requirements in AML solution

AML is a modular product and depending on the exact requirements of the financial organisation, specific modules can be enabled/ disabled. Following is a list of modules supported by the software:

- ✓ List Manager
- ✓ Link Analysis
- ✓ Risk Scoring
- ✓ Transaction Monitoring
- ✓ Case Management
- ✓ Reports/ Compliance

9.1.3.1 List Manager

This module is the key to building society's Know Your Customer (KYC) program. List manager is used to manage various lists like OFAC-SDN and Politically Exposed Peoples (PEPs) List1. Users can maintain internal Watch-lists to monitor and profile their customers.

9.1.3.1.1 KYC Checklist

User can define checklists on the Customer / Account Static Data to generate reports on mandatory information required for different type of accounts. This mandatory information could either have been prescribed by the regulatory authority of the country or it could be formed as a part of the building society's internal policies.

9.1.3.2 Link Analysis

The Customer Master is a repository of customer information and houses the Customer Account Details, Address Details, Customer Info, Introducer Details and Personal Details. The Customer Master provides a 'Search' facility to find a particular Customer record. AML provides a cross-referencing facility to the corresponding Account(s) information (of customers) from the Customer Master. This is the "Customer-to-Account-Mapping".

9.1.3.3 Risk Scoring

This Module categorizes Accounts into the following Risk Categories:

- ✓ Low Risk
- ✓ Medium Risk
- ✓ High Risk
- ✓ Extreme Risk

AML derives Customer Risk from the Account Risk Categorisation.

The following Risk Parameters are considered to arrive at Account Risk:

- ✓ The risk associated with the customer's Nature of Business
- ✓ Building society Product Risk
- ✓ Customer Geographic Risk – The risk associated with a Country/ Geographic region
- ✓ Customer Type Risk with regard to its susceptibility to Money Laundering
- ✓ List Risk – The risk the Building society is exposed to when customer(s) match with Blacklists/
- ✓ Watch Lists
- ✓ Mode of Operation of the account
- ✓ Source of Funds of the customer
- ✓ Occupation of the customer
- ✓ Networth of the Customer
- ✓ Account Status, as in whether dormant, etc
- ✓ Credit Rating of the customer

AML gives the User the flexibility to select risk parameters, and therefore, to compute Customer Risk in accordance with Building society's established practice.

9.1.3.4 Transaction Monitoring

Transaction Monitoring is the process of monitoring transactions post execution in order to identify unusual transactions. The parameters for activity that can be deemed as normal are defined as per the regulatory requirements where applicable or as per the policies of the building society. AML scrutinizes each and every transaction and qualifies the same against thresholds, control lists, dynamic benchmarks and user-defined benchmarks.

The following sub-modules facilitate transaction monitoring:

- ✓ Alerts Editor
- ✓ Benchmarking
- ✓ Alerts Manager
- ✓ Transaction Viewing Center (TVC)
- ✓ Multi-Dimensional Analysis
- ✓ Visual Event Response Builder (VERB)
- ✓ Alerts Management

9.1.3.4.1 Alerts Editor

'Alerts' serve as early indicators to potential money-laundering activities. Alerts are exceptions to the rules that define 'normal' behaviour.

AML is a Rule-based Transaction Monitoring system. It allows the User to configure rules – "Alert Scenarios" in AML terminology, based on static information and/or transactional attributes, such as frequency, amount, etc. Alert Scenarios can be applied to a group of accounts or to a single specific account.

These can then be qualified to differential benchmarks/threshold limits duly representing the varied profiles of customers to whom these are applied. AML is equipped with a library of Alert Scenarios that are categorized thus:

- ✓ Real-Time Alerts (Online Alerts)
- ✓ Non Real-Time Alerts (Offline Alerts)
- ✓ Subjective Alerts (User Initiated Alerts)

9.1.3.4.2 Benchmarking

Alerts are triggered on violation of predefined parameters termed as "benchmarks". This term can also be understood as a limit for reporting or flagging exceptional. transactions. A Benchmark is an explicitly defined figure based on the Account/ Customer Profile and transactional activity.

9.1.3.4.3 Alerts Manager

The Alerts Manager Screen is the default screen that appears when the User logs into AML. The screen displays all alerts/ exceptions that have been triggered on transactions, along with the Alert message, transaction information and 'benchmark' details the transaction was qualified for. This module facilitates Alerts Management from the time they are triggered until appropriate action is taken.

9.1.3.5 Transaction Viewing Center (TVC)

The AML Transaction Viewing Center (TVC) is designed to provide for information on all transactions of the Building society.

9.1.3.6 Multi-Dimensional Analysis

Flip Tables deliver substantial and multidimensional insight into real-time Customer, Product and Instrument information, which is dynamically updated by way of a cross-referencing facility. Easy screen-to-screen navigation capability helps instantaneous and simultaneous analysis of inter-related information.

9.1.3.7 Visual Event Response Builder (VERB)

AML offers VERB as a tool for developing Alert Scenarios. VERB is a flexible Rules Engine that enables Users to develop new Rules based on their own logic. A Rule is an alert condition. The system raises alert notifications on transactions that satisfy rule conditions. This flexibility encourages the Building society to be more analytical and pro-active in its Transaction Monitoring approach.

VERB is provided in addition to the pre-defined Alert Scenarios that AML is equipped with.

9.1.3.8 Alerts Management

The following critical features yield AML the distinction of being a powerful Alerts Management solution – Alert Prioritisation, Alert Weightage, Alert Resolution, Case Manager, False Positive Management, White List Management etc.

All the requirements and processes of the AML solution are shown in Fig 9.6 and 9.7:

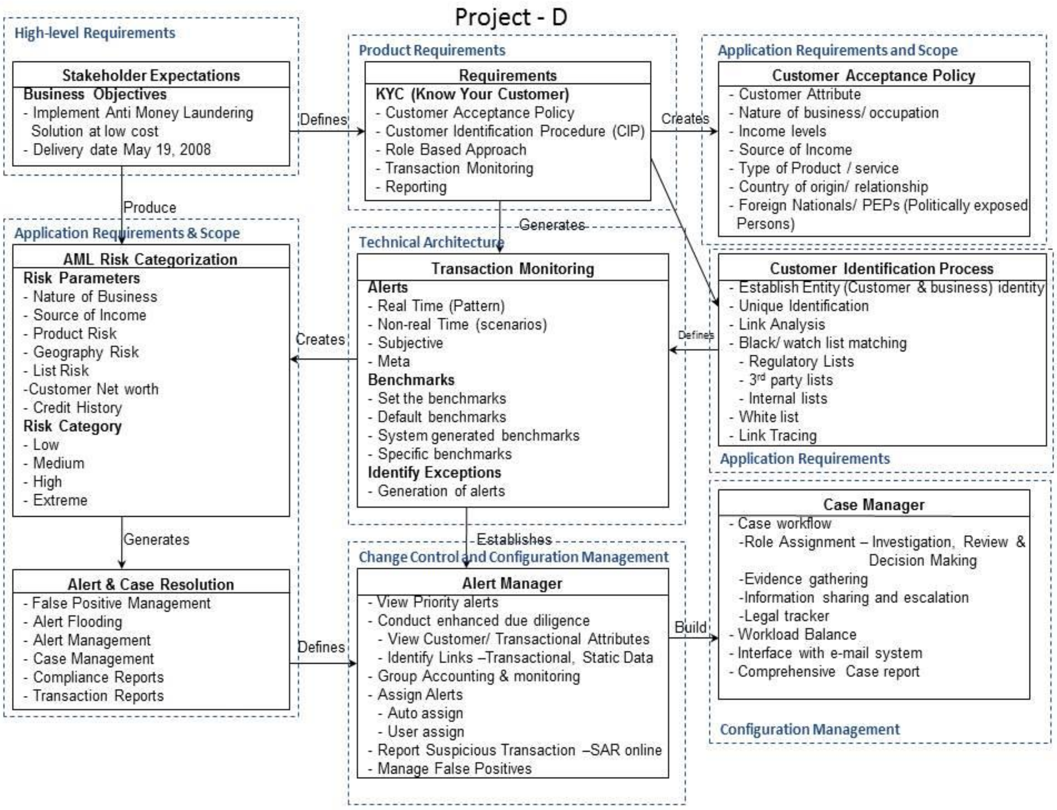

Figure 9.6 Processes and Requirements in AML solution

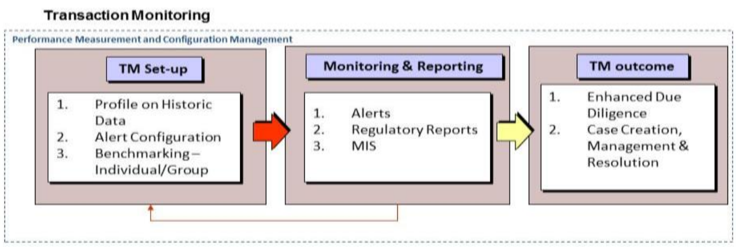

Figure 9.7 Transaction Monitoring

The object diagram for the Project Stakeholder management class diagram in chapter 6 of the model (Fig 6.1) is given below in the figure 9.7

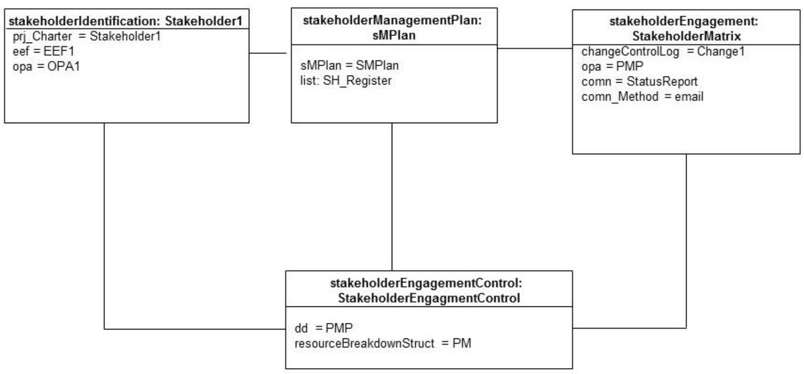

Figure 9.8 Object diagram for the Project Stakeholder management

The object diagram for the Project Closure management is given in the figure 9.9 based on the class diagram in Figure 5.5 in chapter 5 is shown below:

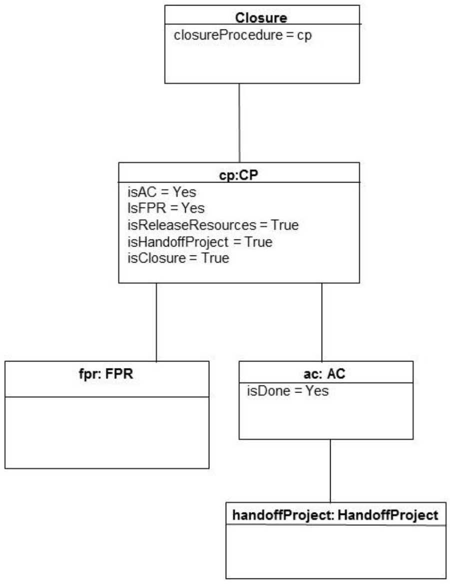

Figure 9.9 Object diagram for the Project Closure management

The product was developed and tested with sample data offsite and found that that the solution is meeting the requirements as defined in the scope and tested by client stakeholders. The errors were fixed and client sign-off for the test run were taken.

The implementation team was brought onsite for the final implementation and handover of the solution. The legal team and logistics team were engaged well in time to sort out visas, travels, boarding and lodging of the team onsite. This was a very critical step as it could have delayed the project implementation phase.

Steps were taken for integration and data sharing of the client application and the new solution. Various tests from unit testing to UAT and Performance tests were performed and parallel run of the application was taken to check the authenticity and correctness of the data and reports. The client team signed the approval of the solution and the site went live on the date as planned. Making a good project management plan and monitoring it closely along with the involvement of all the stakeholders from the client side and solution provider side, and managing various communication channels along with the effective change management and risk management plan made the project a huge success.

The test scenarios, test data requirements were captured while doing the business and functional analysis of the system. The test scripts were prepared while solution design was developed. The test scripts were run on the raw data and results compared with the expected results. All the boundary conditions were also tested along with the negative test data.

Regular and timely communications were sent to all the relevant stakeholders as listed in the Project plan. This ensured the transparency with the stakeholders and also timely resolution of any risks and problem areas.

Daily status meetings were planned for the implementation duration for managing the plan for the day, handing any risks, fixing the errors, running the system in parallel, comparing the results and then taking any preventive and corrective actions for the day. Daily reports were submitted to all the relevant stakeholders so that project implementation can be managed effectively and efficiently to deliver the project on time.

9.1.4 Fit/Gap Analysis:

The Fit/Gap Analysis documents all potential gaps. This deliverable also holds the information for the preliminary analysis of each potential gap, determining if it is indeed a gap or if the project fits the requirements of PMBOK standard.

The Fit/Gap analysis help the early detection of potential gap in the deliverables/ documentation and controls. This analysis provides ab opportunity to the project managers for providing the right kind of controls, preventive and corrective actions for managing and delivering the project successfully within the agreed time, scope and cost. Project managers can identify the risks early and apply the correct processes, controls and actions to manage the project. This will help the organisation to realise the benefits as planned.

The information and analysis from the Fit/Gap analysis can be used effectively to create the Lesson Learned Log and may be highly beneficial for the management of the future projects. For each potential gap, a brief summary of the analysis, either the method to "fit" the requirements, or the potential resolutions for a gap are documented in this deliverable.

- Project managers can use this deliverable to understand the gaps and define controls required to manage and deliver the project as per the plan. They also provide input in the gap analysis process, helping to determine the fit versus the gap, as well as any potential gap solutions.
- The team can use this deliverable to implement the various preventive and corrective actions to monitor and control the project scope, time and cost. In addition, they provide input on a gap to help determine the best gap resolution.

Documents created during the project:

- Customisation of Requirements
- Project Plan
- Risk Management Plan
- UAT plan
- UAT and Go-Live Sign-offs
- Lesson learned log
- Status Report and Minutes of Meeting templates

- Support plan and SLAs

9.1.5 Role of Workshops

The workshops were conducted to do the followings:

- Understand the project work
- Share the project management knowledge and exchange the ideas
- Help in planning the project management work
- Provide the guidelines for various documentation in the project work such as Project plan, requirements gathering and analysis, lesson learned log, sign-offs, stakeholder matrix etc.
- Plan and do the Fit/Gap analysis of the project work with the standard and model

Fit/Gap Analysis has been done on the Project Closing Process Group and Project Execution process group for this project. The Fit/Gap analysis is given here in section 9.2.

The workshops also helped to demonstrate the followings:

- Proposed models are correct, helpful and make it easier for the people to understand the PMBOK processes.
- The documents deliverables and templates proposed are highly useful for this project and can be easily reused in other projects.
- Fit/Gap Analysis helped the project team to gaps early and find a resolution to close the gaps early. The workshops helped the project team to get more knowledge in managing the projects a better way as well as conforming to the PMBOK standard. This helped in creating the lesson learned log for other projects and helping them improve the processes in the project management area.

9.2 Fit/Gap Analysis for Project Closing and Project Execution Process Group:

See the specific instructions below for each column.

Fit/ Gap ID	Proces/ Knowledge Area ID	Process/ Knowledge Area Description	MetaModel Element (Class/ Attribute/ Operation)	Business Process	Scope	Gap	Resolution Type	Comments
Enter the fit/ gap ID.	Enter the Process/ Knowledge ID	Describe the Process/ knowledge Area		List the business process (e.g. Billing, Customer Service Design, Client Financial Management, etc.)	Select: Y - In Scope, N - Out of Scope, or Other (specify in Comments)	Select: Fit, Gap, or Other (specify in Comments)	Select Workaround, Configuration, Report, Interface, Conversion, Extension, Form, or Other (specify in Comments - e.g. 3rd party software or custom development)	Insert any comments here to explain the previous columns as needed.
		Project Closing Process Group						
F1.2	3.7.1	Administrative Closure Procedure	ClosureProedure Class	Follow the Project Closure procedure	Y	Fit	None	UAT Sign-off
F1.3	3.7.1	Administrative Closure Procedure	ClosetheProject()	Sign-off the Project	Y	Fit	None	Project Closure Report
F1.4	3.7.1, 3.7.2	Hand off completed product, service, or result	HandoffProject()	Sign-off the Project	Y	Fit	None	Go-Live Sign-off
F1.5	3.7.1	Confirm work is done to requirements	AcceptanceCriteria attribute	Sign-off the Acceptance	Y	Fit	None	Final Performnace Sign-off, UAT Sign-off
F1.6	3.7.2	Contract Closure procedure	AccountClosure (AC) class	Sign-off any contracts	Y	Fit	None	
F1.7	3.7.1	Release Resources	ReleaseResources()	Release the resources	Y	Fit	None	Release the resources working on the Project
F1.8	3.7.1	Final Performance Reporting	CreateFinalReports()	Publish the final report showing the metrics and targets achieved.	Y	Fit	None	Final Reports, Support and Maintenance guidelines and SLA
F1.9	3.7.1	Update Knowledge Management database	CreateLessonLearnedLog ()	Create the Lesson learned log for future projects	Y	Fit	None	Created the final lesson leraned log.
		Project Execution Process Group						
G3.1	3.5.1, 3.5.7	Direct and Manage Project Execution (3.5.1, 3.5.7)	PMPlanExecution class	Rewards/ Recognition	N	Gap	If the Project completed on time and the client signed-off as planned, then pursue with Senior Management for some rewards and recoginition.	Rewards Recognitions were not planned earlier as company did not have such policy.
F3.1	3.5.2	Perform Quality Assurance (3.5.2)	ManageQuality() Operation UpdateChangeControlLog() operation	Quality Audits	Y	Fit		
G3.2	3.5.2	Perform Quality Assurance (3.5.2)	Manage Quality Operation Update Change Control Log operation	Online Reports for SOCA	N	GAP	SOCA changed the process of submission of reports during the implementation phase.	Since the Online submission was still in the later part of the year, hence it was planned to deliver in the phase-2
F3.2	3.5.3	Acquire Final Project Team (3.5.3)	AcquireTeam() operation	Team Onsite	Y	Fit		Plan for the team Visa/ stay in UK with Logistics team
F3.3	3.5.4	Develop Project Team (3.5.4)	TeamBuilding() Operation	Select team with right Skills and experience	Y	Fit		Select people with appropraite skills and experince for onsite and offshore work so that cost can be optimised.
G3.3	3.5.5	Give recognition & Rewards (3.5.5)	GiveAwards() operation	Approval for rewards to be given to the team	N	Gap	A proposal was submitted and got approved for a Souvenir to each team member	
F 3.4	3.5.2	Implement Changes, defect repair, preventive and corrective action (3.5.2)	ChangeControl class PreventiveAction() operation CorrectiveAction() Operation DisasterRecovery() operation	Part of the Project Plan	Y	Fit		
F3.5	3.5.6, 3.5.7	Information Distribution (3.5.6, 3.5.7)	Communication (COMN) attribute Update_RTM() operation Cmaudits() operation DefineChangeControlBoard() operation Update RiskResponseLog() operation	Status Reports and RAG reports for seniors Management	Y	Fit		
F3.6	3.5.8	Request Seller Response (3.5.8)	Request_Seller_Response operation	Not Required	Y	Fit		No Third party involved
F3.7	3.5.8	Select Seller (3.5.8)	AuthoriseWork operation()	Not Required	Y	Fit		No Third party involved
F 3.8	3.5.2	Continuous Improvement (3.5.2)	ChangeControl class ConfigurationManagement (CM) class	Part of the Project Plan	Y	Fit		All changes captured with approvals from the stakeholders

9.3 Lesson Learned Log:

Please find below the example/ sample of the lesson learned log.

LESSONS LEARNED LOG						
Project Name:			<optional>			
National Center:			<required>			
Project Manager Name:			<required>			
Project Description:			<required>			
ID	Date Identified	Entered By	Subject	Situation	Recommendations & Comments	Follow-Up Needed?
1	01/01/01	John Doe	**EXAMPLE:** Issue escalation	**EXAMPLE:** Issue escalation took too long	**EXAMPLE:** Have in place a solid communication plan that outlines the escalation process, the roles & responsibilities of individuals involved in that process, and a required response time.	

9.4 Project Closure Report Sample:

Project Closure Sample is attached in the Appendix -1.

9.5 Sign-off Sheet Sample:

Sign-off Sheet

Project: ______________________________
Insert the project name.

Sign-Off for: ______________________________
List the deliverable ID and name.

System: ______________________________
List the system name and version/ release.

9.6 Sign-off:

______ Accept

______ Accept with modifications

______ Do not accept

______________________ ______________________ __________

Project Sponsor Signature Date
Print the project sponsor's name.

______________________ ______________________ __________

Project Manager Signature Date
Print the project manager's name.

______________________ ______________________ __________

Technical Architect Signature Date
Print the technical architect's name.

<Other Relevant Stakeholder> Update title and print stakeholder name.	Signature	Date
<Other Relevant Stakeholder> Update title & print stakeholder name.	Signature	Date

10. Conclusions

10.1 Summary

This research successfully defined and developed models for Project Management (PM) process based on PMBOK and able to established the followings:

- Feasibility of defining the metamodels for all the processes
- Definition of meta models and rules for all the core PMBOK processes:
  - 5 Project Management Process Groups
  - 10 Project Knowledge Areas
  - 47 Project Management Processes
- Defined the mapping from the PMBOK standard to the metamodels

This research consisted of:

1. Study of previous research and literature review in the field of Project Management and categorising the research depending upon the various aspects of research topics.
2. The defining of Project Management (PM) process based on PMBOK and study its feasibility has been done to accomplish the followings:
   a. To establish the feasibility of defining/ formalisation of PMBOK processes, defining meta models for core PMBOK processes.
   b. This research has defined models for the Project Stakeholder Management and Project Closure Process Group and also provided the templates/ samples for the same. Project Managers can create their own templates addressing the steps. Similar models were created for the other process and knowledge areas and case study completed with Fit/Gap analysis.
   c. The models were refined during the research work to be more precise, in particular to represent all necessary data as attributes (or associations) of the classes. The purpose of the models is to provide a specification of PMBOK. The use is to specify the PMBOK data and process in sufficient detail that gaps in particular projects can be identified (either manually or preferably, by a management support tool).
   d. Metamodels and mapping defined could be highly useful for the easier understanding of PMBOK standard.
   e. Use of models can help in reusability of the processes/ documents/ deliverables and it will help the consistency in project management area in the organisation.

f. The overall benefits can come in the shape of reliability in the delivery of the projects and improving the effectiveness of the processes across various projects with increased efficiency in the project management and delivery.

3. This research work has defined high level models for the followings:
   a. Programme Management
   b. Distributed Offshore/ Onshore Software Projects

Overall this research showed that it is possible and useful to formalise all parts if a substantial PM standard. This research work applied the formalisation to the Fit/Gap analysis of an actual project.

10.2 Books, Papers Published and Presentations:

- Singh, Ravinder and Lano, Kevin, "Defining and Formalising Model Driven Approach for PMBOK Processes" published in IEEE International Conference INDIACom-2017 and 3rd International Workshop on Information Engineering and Management IWIEM 2017, March 1-3, 2017
- Singh, Ravinder and Lano, Kevin, "Defining and Formalising Project Management Models and Processes", published in International Journal of Advanced Research in Computer and Communication Engineering (IJARCCE), Volume 5, Issue 6, June2016, Impact factor 5.332
- Singh, Ravinder and Lano, Kevin, "Literature Survey of previous research work in Models and Methodologies in Project Management", published in International Journal of Advanced Computer Science and Applications (IJACSA), Vol. 5, No. 9, Sept 2014, Impact factor 1.324
- Singh, Ravinder and Lano, Kevin, "Defining and Formalising Project Management Models and Processes", published and presented in IEEE Science and Information (SAI) Conference 2014, August 27-29, 2014, London U.K, pp 720-731
- Singh, Ravinder and Lano, Kevin, "Development Process Patterns for Distributed Onshore/Offshore Software Projects", published in International Journal of Advanced Computer Science and Applications (IJACSA), Vol. 5, No. 6, June 2014, pp 70-88, Impact factor 1.324

Book

- Published 2 papers as chapters as one of the editors in the Book titled, "Model driven Business Process Engineering, Singh", Lano, Kevin Ravinder, Maroukian, Krikor, published by Bentham Science, May 2014 and Amazon, 2015

Conferences:

- Keynote presentation on "Processes for Managing Service Transition Efficiently" at 6th itSMF South East European Conference, Athens, Greece, April 19, 2013.
- Keynote presentation on "Model Driven Project Management", in 21st International Conference on Interdisciplinary Mathematics, Statistics and Computational

Techniques (IMSCT 2012-FIM XXI) at Panjab University, Chandigarh, India, Dec 15-17, 2012

- Expert Talks in workshop on “Software Project and Process Management”, at BBSBEC, Fatehgarh Sahib, India, Dec 17-20, 2012
- Presentation on “Model Driven Approach for Programme Management” in Model Driven Business Process Engineering Workshop, KCL, London, April 30, 2012.
- Singh, Ravinder and Lano, Kevin, “Analysis of Previous Research work in Models and Methodologies in Programme/ Project Management” in Model Driven Business Process Engineering Workshop, KCL, London, April 30, 2012

Feedback from the various conference, workshops and journals helped the author to fine tune the models for greater accuracy and mapping of the models to the PMBOK. The feedback provided the following main inputs:

- Include more details in the mapping of activities of PMBOK and models
- Provide reasoning for the modelling language used (Updated in chapter-4)
- Provide object models for one or two areas of the case study

The feedback has been used to update various mapping and activities in Chapter 5, 6,7, 8 and 9.

The workshops and conferences provided an opportunity for the direct feedback and discussions on this research work and it provided the good inputs from the experts who are working on the similar area.

10.3 Evaluation Process by means of case study

1. Conducted the workshops with the project manager and team of AML project to understand the project and define the activities that would be done in this research.
2. Develop the template for the agreed documentation so that it can be used for the research and explain to the AML team its relation to their AML project work.
3. Help the team with the use of PMBOK standard on the project work using the models developed.
4. Analysed the application of proposed formal methods/ models in the case study and the Fit/Gap analysis was done to document the shortcomings/ gaps with respect to the compliance to PMBOK 5th Edition. This research work is able to represent the case study’s project management process and documentation within the metamodels produced by during the study. This helped to find the consistency of the projects with respect to following the PMBOK standard:
    - This analysis was used to document the potential gaps between the model and project/ case study.
    - This deliverable produced were able to provide the information for the preliminary analysis of each potential gap, determining if it is indeed a gap or if the project fits the requirement of PMBOK and is consistent as per the model.

- The above analysis and data helped us to identify activities/ tasks/ deliverables which may have been overlooked or have gone unnoticed during the project management. For each potential gap, the analysis was done:
    - To identify the potential impact of such gaps on the project.
    - To resolve the difference/ gap between model and project by creating appropriate project documents/ deliverables.
    - To accept the difference/ gap with suitable reasoning/ justification e.g. that project has been tailored to meet specific requirement, etc.
    - To provide communication to various stakeholders about the risks/ issues/ errors based on the above analysis. This would help them take appropriate preventive and corrective actions for better planning & management, execution, monitoring and control of projects with earlier identification of gaps.
    - Gap is identified by seeing what necessary data from meta-model is omitted.

5. Benefits for the approach and doing Fit/Gap analysis are:
    - Specification of requirements for PMBOK tools
    - Check project compliance with PMBOK 5th edition
    - Early detection of missing activities/ tasks/ processes/ deliverables etc.
    - Organisation can plan and execute for preventive and corrective actions more efficiently and effectively.
    - Risks can be mitigated in a more effective manner and can help to prevent them turning into issues
    - Communications across various stakeholders can be improved
    - Auditing of the organisation's various projects as per company standards would be easier and less time consuming
    - Better lesson learned logs and knowledge base for future projects
6. The research was analysed with the project managers to study the applicability of the models and the feedback has been that these models provide the good basis and foundation for the easier understanding and use of PMBOK standard methodology for the managing projects successfully.
7. There may be some projects which could not be modelled as per the proposed model. This may not imply that the project is wrong or the model is wrong but there could be exception to the model. Such exceptions may come and the model may have to be further tailored and enhanced for such projects/ areas. This would provide an opportunity for future research to highlight those exceptions which does not follow the PMBOK model and create formalisation for such situations/ areas.
8. The research could be helpful in the future for creating programmed models/ frameworks for automation of project management processes.

11. Future Scope

The formalised models presented in the study could be enhanced for the following scenarios:

1. The formalised models can be extended to other methodologies, e.g. PMBOK-Agile, PRINCE-2, etc. The models presented in this research can be easily modified and updated to develop the models for other methodologies and frameworks. This could be a great use for the organisations as this research provides them the sufficient details, information and data for developing models for the methodology they are using.
2. The organisation or project managers can develop aggregation and generalisations wherever possible to enhance the models for their projects and applications. This may help the project managers to categorise and group various processes, activities, documents, and deliverables as per the organisation policies and usage.
3. Create reusable modules for different projects. The models could provide a good foundation to make reusable models as per the requirements of the organisation. The organisation can hope to better the efficiency and productivity of project delivery by reusing the models on various projects.
4. Project managers or the organisations can develop customisable modules using inheritance properties for enhancing capabilities for existing class as per the needs and requirements. This could help the organisation to tailor the models as per their needs to increase the effectiveness and efficiency of the programme. It is acceptable for projects to tailor the formalised models to meet their specific needs. Depending on the project's scope, it may be necessary to add or remove processes and deliverables, or it may be necessary to change a deliverable's name to match the client's terminology.
5. The exceptions can be handled as per the following:
    - Following the organisation's guidelines, tailor the methodology processes and deliverables as necessary to meet project requirements and constraints.
    - If a project needs to exempt the methodology and/or to certain processes, deliverables, or tools, it can submit an exception request. The exception request should be approved by the person identified by the appropriate operating group with the responsibility of approving the project's exception requests.

    The following types of requests may typically require approval:

    - Policy exception: These exempt a program or project from the organizational policy requiring use of the current methodology.
    - Process exception: These allow a program or project to omit a required process (e.g., workstream, stage, activity, task, or step within the organisation's methods).
    - Deliverable exception: These allow a program or project to omit a required deliverable. Some deliverables may not be waived.

Tailoring does require approval. Types of tailoring include the following:

- Process tailoring: This modifies a required process or process component. This may include adding new tasks or modifying existing tasks.

- Deliverable tailoring: This modifies a required deliverable template. This may include adding new sections, modifying sections, or removing sections.
- It is expected that most requests for process/deliverable exceptions take place during project planning activities. If, during later stages of development the project manager and his or her team discover additional needs to seek waivers, they may do so by executing the required request and approvals.

6. The formalised models presented in this research can provide the required data, classes, operations and other detailed information which can be used to develop the full automation of the project management processes and standards for PMBOK and PRINCE-2 or other project management methodologies.

This research presented the high-level models for the followings methodologies:

1. Programme Management
2. Development Process Patterns for Distributed Onshore/Offshore Software Projects

The above high-level models could be enhanced for full model driven transformations. The models presented in the research can be used to develop classes, data and operations for creating the formalised for the above methodologies. The development can also look into generating consistent and reusable components. This will provide the organisation with greater automation of processes and deliverables which will help in increasing their efficiency, effectiveness and productivity.

12. Appendix-1 Class Dictionary

Table 12.1 Class Dictionary

S.No.	Class name	Created	List of Models where this class is used		Comments
			Project Process Group	Project Knowledge Management Group	
1	Scope	Project Initiating Process Group	Project Planning Process Group	Project Scope Management, Project Time Management, Project Cost Management	
2	ProjectStatementofWork (SOW)	Project Initiating Process Group	Project Planning Process Group		
3	Skills	Project Initiating Process Group	Project Planning Process Group		
4	Assumptions	Project Initiating Process Group			
5	Constraints	Project Initiating Process Group			
6	CurrentCapabilityAssessment	Project Initiating Process Group			
7	EEF	Project Initiating Process Group		Project Stakeholder Management, Project Integration Management, Project Cost Management, Project HR Management, Project Communication Management	Enterprise Environment Factor
8	PM	Project Initiating Process Group			Project Manager

S.No.	Class name	Created	List of Models where this class is used		Comments
9	HighLevelRequirements	Project Initiating Process Group		Project Scope Management	
10	Prj_Charter	Project Initiating Process Group	Project Planning Process Group	Project Scope Management, Project Cost Management, Project Communication Management	Project Charter
10	ProjectManagementPlan (PMP)	Project Planning Process Group	Project Initiating Process Group, Project Monitoring and Controlling Process Group	Project Stakeholder Management, Project Integration Management, Project Time Management	
11	Quality (QM)	Project Planning Process Group		Project Quality Management	
12	Communication (COMN)	Project Planning Process Group		Project Stakeholder Management, Project Communication Management	
13	ProductRequirements	Project Planning Process Group	Project Initiating Process Group		
14	ApplicationRequirements	Project Planning Process Group			
15	TechnicalArchitecture	Project Planning Process Group			
16	Time	Project Planning Process Group	Project Initiating Process Group	Project Time Management	
17	Schedule	Project Planning Process Group		Project Time Management	
18	ResourceRequirment (RR)	Project Planning Process Group		Project Time Management, Project Cost Management, Project HR Management	

S.No.	Class name	Created	List of Models where this class is used		Comments
19	OrganisationProcessAssets (OPA)	Project Planning Process Group	Project Initiating Process Group	Project Stakeholder Management, Project Integration Management, Project Cost Management, Project Communication Management	
21	DD	Project Planning Process Group		Project Stakeholder Management	Document & Deliverable
22	Cost	Project Planning Process Group	Project Initiating Process Group	Project Time Management, Project Cost Management	
22	PMPlanExecution	Project Executing Process Group		Project Integration Management	
23	DisasterRecovery (DR)	Project Executing Process Group	Project Monitoring and Controlling Process Group		
24	ChangeControl (CC)	Project Executing Process Group	Project Monitoring and Controlling Process Group	Project Integration Management	
25	ConfigurationManagement (CM)	Project Executing Process Group	Project Monitoring and Controlling Process Group		
26	PerformanceMeasurement (PMEAS)	Project Monitoring and Controlling Process Group		Project Integration Management	
27	Closure	Project Closing Process Group		Project Integration Management	
28	ClosureProcedure (CP)	Project Closing Process Group			
29	FinalPerformanceReporting (FPR)	Project Closing Process Group			
30	AC	Project Closing Process Group			Acceptance Criteria

S.No.	Class name	Created	List of Models where this class is used		Comments
Project Knowledge Management Areas					
1	StakeholderManagementPlan	Project Stakeholder Management			
2	StakeholderIdentification	Project Stakeholder Management	Project Initiating Process Group		
3	StakeholderEngagement	Project Stakeholder Management	Project Initiating Process Group		
4	StakeholderEngagementControl	Project Stakeholder Management			
5	ProjectCharter	Project Integration Management	Project Initiating Process Group		
6	ProjectMethod	Project Integration Management			
7	Infrastructure	Project Integration Management			
8	RequirementCollection	Project Scope Management	Project Initiating Process Group, Project Planning Process Group		
9	ScopeManagementPlan	Project Scope Management			
10	ScopeDefinition	Project Scope Management	Project Initiating Process Group, Project Planning Process Group		
11	ScopeControl	Project Scope Management			
12	ScopeValidation	Project Scope Management			
13	WBSCreation	Project Scope Management	Project Planning Process Group		

S.No.	Class name	Created	List of Models where this class is used		Comments
14	ActivityDefinition	Project Time Management	Project Planning Process Group		
15	ActivitySequence	Project Time Management	Project Planning Process Group		
16	ActivityDuration	Project Time Management	Project Planning Process Group		
17	ActivityResource	Project Time Management			
18	ScheduleControl	Project Time Management	Project Planning Process Group		
19	CostEstimate	Project Cost Management	Project Initiating Process Group, Project Planning Process Group		
20	CostManagementPlan	Project Cost Management			
21	BudgetDetermination	Project Cost Management			
22	CostControl	Project Cost Management	Project Planning Process Group, Project Monitoring and Control		
23	QualityAssurance	Project Quality Management	Project Monitoring and Controlling Process Group		
24	QualityControl	Project Quality Management			
25	ProjectTeamAcquisition	Project HR Management	Project Planning Process Group		
26	HRM Plan	Project HR Management			
27	ProjectTeamDevelopment	Project HR Management	Project Executing Process Group		
28	ProjectTeamManagement	Project HR Management	Project Monitoring and Controlling Process Group		

S.No.	Class name	Created	List of Models where this class is used		Comments
29	RiskManagementPlan	Project Risk Management			
30	RiskIdentification	Project Risk Management	Project Planning Process Group		
31	QualitativeRisk	Project Risk Management	Project Planning Process Group		
32	QuantitativeRisk	Project Risk Management	Project Planning Process Group		
33	RiskResponsePlan	Project Risk Management			
34	RiskControl	Project Risk Management	Project Monitoring and Controlling Process Group		
35	CommunicationPlan	Project Communication Management			
36	COMNControl	Project Communication Management	Project Planning Process Group		
37	Procurement	Project Procurement Management	Project Planning Process Group		
38	ProcurementManagementPlan	Project Procurement Management			
39	ProcurementControl	Project Procurement Management			
40	Supplier	Project Procurement Management	Project Executing Process Group		
41	ProcurementClose	Project Procurement Management			

Appendix-2 Project Closure Report Template

<Project Name>

Project Closure Report Template

Version: 1.0

The following template is provided for use with the Project Closure Report deliverable. The blue text provides guidance to the author, and it should be deleted before publishing the document.

See the Revision History table at the end of the document for revision status.

Table of Contents

This report is used to communicate and summarize the project. This report should include project results, pertinent project metrics including schedule and budget plan versus actual, project successes, and project shortcomings.

- Project Closing Summary

- ***Project Overview***

Provide an overview of the goals and scope of the project. Refer to the Project Plan.

- ***Project Accomplishments***

Document the results of the project. Provide a description of what was actually achieved versus the original intent of the project. Explain any variations.

- ***Project Productivity Review***

Document general and process related information including overall productivity achieved, quality delivered, processes used and process deviations, estimated and actual start and stop dates, and tools used on the project.

Document size and effort including number and complexity of software modules, peak number of FTEs, and duration in total hours, calendar days and person-days.

Document summary of defects found during the project.

- ***Project Observations and Recommendations***

Document any potential areas of focus that could be pursued as follow-on work. Provide an assessment of those areas and recommendations for future action. Customize the table to fit the nature of the project.

Area of Focus	Assessment	Recommendations
Organizational Changes	• New Leadership Team is in place • Offices will still need to complete implementation of HR, administrative, and office move activities	• Establish and implement communications strategies to ensure that employees are provided with pertinent information during the implementation process • Ensure new leaders are 'walking the talk'; make leadership changes as necessary • Ensure that position descriptions and levels are finalized and communicated in a timely manner
Strategic Management and Performance Measurement	• Initial Office-specific outcomes have been defined • Baseline and target Office-level performance measures are being defined	• Senior Leadership Team must clearly understand how performance measurement will be linked to the overall strategic management processes • Accountabilities for achieving measures need to be assigned and cascaded through the organization • A program for tracking status and managing consequences must be defined and executed
<insert other areas>	•	•

- ***Supplier Relationships***

Describe any supplier relationships related to the project. Indicate the supplier the product or service, the impact on project performance, the overall satisfaction with the supplier, any areas for concern, and whether the supplier organizations should be used again in the future. If the contractor was obtained via Contractor Exchange ensure that the Contractor Exchange (Cx) Representative receives feedback from the Hiring Manager on his or her satisfaction with the Contractor. The Hiring Manager's input can later be used as a reference for future staffing opportunities for both the contractor and the vendor.

NOTE: This section may be omitted if the project did not utilize external suppliers to complete the project.

- Project Deliverables

Document all deliverables that were turned over to client.

Deliverables	Owner	Date Submitted
•		
•		
•		

- ***Harvested Knowledge Assets***

Include list of knowledge assets contributed to the organization. Contribute pertinent documents and artifacts in the appropriate repository in the Knowledge Exchange or to Capability or Methods Development groups. Assets should be packaged and contributed 2 – 3 weeks before project end. Refer to the Knowledge Plan to confirm assets that have been identified as key assets to be contributed.

- ***Deliverables***

Include list of deliverables contributed to the organization.

Deliverables	Status	Date Complete
•		
•		
•		

- ***Actuals***

Include status of submission of project actuals. Submit "actuals" data to the standard estimating tool used to generate the original project estimates. Actuals must be submitted to the tool owner of ABC Delivery Estimator or any other estimating tool being used 1 - 2 weeks before project end.

- ***Project Metrics***

Include final project metrics analysis. Populate the Measurement Reporting Tool with final project metrics and document the results in this section.

- ***Process Improvement***

Include reviews from the development process and client experiences that may benefit future projects.

- ***Record Retention***

Include status of records archival and disposal. Retain or dispose of archives and records in compliance with contractual obligations and applicable legal and regulatory requirements, such as tax or data privacy laws, which may vary by jurisdiction. Refer to ABC Policy 123 for additional details.

Revision History

Date	Version	Description	Author

Appendix-3 Stakeholder Goals and Expectations Template

<Project Name>

Stakeholder Goals and Expectations Template

Version: 1.0

The following template is provided for use with the Stakeholder Goals and Expectations deliverable. The blue text provides guidance to the author, and it should be deleted before publishing the document.

Table of Contents

- ***Project Background***

Describe the business rationale for the project.

- ***Project Sponsorship***

Describe the purpose of defining project sponsorship.

- ***Project Stakeholders***

List the various project sponsors and stakeholders and their roles. The term "stakeholder" is much broader than the term "sponsor." Though not a complete list, stakeholders typically include groups or individuals who: sponsor the project; generate, review, and approve requirements; participate in the decision making process; develop the application (i.e. project team members); use the application, or support the application.

- ***Stakeholder Profile***

For all stakeholders/stakeholder groups who will influence the project or be impacted by the outcome of the project, enter the stakeholder type (Decision Maker, Influencer, Change Agent, Target), current and desired level of buy-in (Contact, Awareness, Understanding, Acceptance, Commitment), and any planned incentives to increase their buy-in in the table below.

Group	Stakeholder Type	Current Level of Buy-In and Reaction to Change	Desired Level of Buy-In	Incentives to Buy-In

- ***Key Stakeholder Goals and Expectations***

For key stakeholders/stakeholder groups, enter their goals and expectations in the table below.

Name	Group	Role	Responsibilities	Goals	Expectations	Concerns

Goals and expectations should be documented relative to (but not limited to) the following:

- Initial assumptions for planning
- Business goals for the application
- Timing to achieve solution (i.e., target dates)
- Working relationships between the development team, business units, users, etc..
- Customer Experience
- Financial targets
- Deliverables strategy (what deliverables are needed and when)
- Constraints have to be accommodated
- Benefits that have been promised to stakeholders
- Measures of success
- Communications
- Decision process

- ***Stakeholder Involvement Matrix***

For all stakeholders/stakeholder groups, enter where they get involved (project stages), type of involvement (review, sign-off, sharing information, etc.), and the level of involvement (high/medium/low) in the table below.

Name	Group	Stage	Type of Involvement	Level of Involvement

- ***Issues and Risks***

List issues and risks associated with the goals and expectations. Once the issue and risk logs are established for the project, transfer the information contained in this section into them.

Revision History

Date	Version	Description	Author

Appendix-4 Review and Appraisal Letters from Industry Experts

Review and Appraisal Letter from Project Manager of the Building Society

Title: Project Manager for the Building Society

Organisation: Tier-2 Software Product and Consultancy Organisation

Email: xxxxxxxxxxxxxx

Anti-Money Laundering Project Work and support from Ravinder Singh and his research work

Ravinder Singh has helped in the following activities in the Project Work:

- Workshops were run with client and project team to understand the project work and also shared his research topic and requirements with the team. The expectations and outcomes were clearly established, which helped in the overall success of the project
- Developing the Project Plan
- Documentation of Custom requirements
- Creating the Risk Plan
- Developed and provided templates for the Minutes of Meeting, Status Report, Sign-offs, Lesson Learned Log, Support/ SLA, and Project Closure Report
- Ravinder helped the team with the documentation and templates for the project, which can be reused in other projects.
- The models proposed by him during the research work and the project are very helpful and make it easier for the people to understand the PMBOK processes.
- The documents and deliverables proposed in this research work could be highly useful for the project managers and provide them with good basis to plan the project in a better manner.
- The Fit/Gap Analysis can prove to be of huge benefit to the project managers for identifying the short comings and gaps early in the lifecycle of the project. The project manager can close the gaps in the processes, documents, deliverables quickly and this will help them to manage the project in a more successful manner.

Review and Appraisal Letter from Project Manager of the Global Investment Bank

Title: Associate Vice President **Date: Oct 26, 2017**

Organisation: Tier-1 Investment Bank

Email: xxxxxxxxxxxxxx

Questions for research work "**Defining Models for Project Management Processes**" by Ravinder Singh

1. Did the model help to clarify the PMBOK standard?

Ans: Yes, the models developed and the mapping given in the research work by Ravinder Singh have described and defined the PMBOK standard appropriately. The explanations are simpler and easier to follow which could be very useful in project management.

2. Could the models be used to specify tools?

Ans: Yes. The research work provides a PMBOK standard in an organised manner and can be highly beneficial in documenting and developing tools for the project management. The research work can help to build up the project management tools from the basis provided by the research.

3. Could the models be used to help with checking controls and provide fit/gap analysis?

Ans: Yes, these models can provide necessary information with fit/gap analysis which can be really helpful for the project managers to identify the gaps early in the life cycle of the projects. Project managers' can use the fit/gap analysis as the basis for providing the right kind of controls and processes for better project management. The earlier detection of gaps and providing appropriate controls can prove very effective and efficient in project management.

4. Could these models be used in practice? How can they be used, give examples, if possible?

Ans: Yes, the models proposed could be highly useful and practical they have correctly specified the mapping with the PMBOK standard. The flow of information, data, deliverables and operations have been shown which can be make it easier for the project managers to follow the processes. This can help the project managers to identify the right kind of controls in a timely manner. The models can provide the data, documents, deliverables and information for managing the future projects in a more cost effective. This can help the organisations to be more productive and quicker turnaround time.

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Review and Appraisal Letter from Director (Projects) of the SME Consultancy, UK

Tirle: Director **Date: Oct 24, 2017**

Organisation: SME Consultancy, UK

Email: xxxxxxxxxx

Questions for research work **"Defining Models for Project Management Processes"**

1. Did the model help to clarify the PMBOK standard?

Ans: Yes, the PMBOK standard has been correctly depicted and described by these models. This will help the Project managers to understand the PMBOK easily. This will develop the use of PMBOK for better project management.

2. Could the models be used to specify tools?

Ans: Yes. The models have defined the mapping of the models correctly with PMBOK standard and provides a good foundation work and structure, which can help in developing the automated tools for project management.

3. Could the models be used to help with checking controls and provide fit/gap analysis?

Ans: Yes. The models will be very useful in checking the controls for project management. The fit/gap analysis will help the project managers to identify the gaps early in the life cycle of the projects. Project managers can take preventive and corrective actions and implement good and effective control mechanisms in-time for better project management. It will also help the organisation to close the gaps at the earliest and improve the processes as required for future projects.

4. Could these models be used in practice? How can they be used, give examples, if possible?

Ans: Yes. These models are really useful in practice as they have provided the mapping to the PMBOK standard, provided the flow and transitions from one process to another, provides the information for documents and deliverables to be created. This can also help in checking the gaps in the existing processes and will provide information for improving the processes for the future projects.

13. Literature Survey

13.1 Literature Survey

Previous research have been focussed on different aspects of the program and project management such as study of models and framework, empirical, and statistical studies. The studies had been conducted in different industry sectors but most of the research has been in the software and IT industry.

Ref. No.	Category/ Topic	Study Description/ Method/ Argument/ Theoretical Approach	Results, gaps, and Conclusions
	Project Management Models/ frameworks	The following papers [4-8] have used existing project management models and/ or framework for the studies and proposed a few modifications and amendments to make it more effective and efficient.	
4.		This paper discussed and compared project management / frameworks for managing software projects. Authors compared five different methodologies with PMBOK. This research can be of useful help for projects managers to decide on particular methodology for different projects.	This research suggests that project manager must have skills and knowledge of various methodologies used for successful completion of projects. The research highlighted that organisation adhere to one methodology due to cost involved, risks associated with other, and training required for its staff. The paper proposed a generic approach to project management.
5.		This research paper discussed three concepts for project approach. The first step is to develop global project framework for defining objectives, project life cycle and possible steps for projects repeatability.	The paper proposed to follow one specific model but at the same time suggests changing the model dynamically with the project needs using modular and flexible approach.

		The 2nd step is to analyse and build project specifications, plans using transition graphs, and performance measurement baselines. Final step is to describe organisation design, roles, job specifications, deliverables and timelines, etc. for project manager and teams.	The results showed that projects can be managed in a better manner with clear deliverables and milestones using three step approach. The dynamic change in the deliverables/ milestones helps to manage risks and issues.
6.		The research decomposed the Industrial System development into number of phases. Defined the organisation process with results and deliverables i.e. documents or system components which are to be transitioned from one phase to another. Studied different systems and proposed a new mode which was evaluated on another system showing better results.	The research proposed that a bigger system can be managed effectively and efficiently by converting it into smaller phases of planning, analysis, functional and technical design, build, test (unit, assembly, UAT, performance etc.), implementation and maintenance. Furthermore each phase can have transitions to effectively move from one phase to next. The transitions can be managed effectively with some people moving from one phase to next phase so that knowledge can be transferred fully.
7.		This research used object based models for better co-ordination of complex projects. Models used on chip design, identifying problems/ issues with PM tools.	The object based model provided value addition by increasing the stability of the projects, co-ordination between PM tools and structure approach, and hence reducing uncertainty. Model used properties of inheritance from one phase to next, modularity to break project into small pieces of work, using

		Object based models were created to overcome the above issues and summarise the stages/ phases of the project in better way for the project manager.	relation to define interactivity. Data hiding is used to provide information/ access to the authorised people.
8.		This research highlighted that standard project management methodologies should be used by project managers. Project manager should create his/her own set of required documents, deliverables, processes etc. for more efficient approach and better synergy among various project activities and resources.	The paper proposed that project managers should tailor the standard project management processes as per their requirements so as to enhance the efficiency and synergy among project activities and resources. The tailoring could be in terms of deliverables, documents, tools, methods, etc. to be used depending upon the complexity of the project.
	Use of Modelling in Project Management	The following papers [9-12] have tried to implement the system modelling, estimation and object oriented concepts for better project management.	
9.		This research paper proposed a methodology to integrate the use of system dynamics approach to manage risks within the existing project management processes. Project risks change dynamically as the projects are being run and are difficult to predict and manage, this paper suggested the use of system dynamic modelling and framework for better monitoring and control within the PMBOK risk management processes.	Paper suggested the use of System dynamic modelling and framework within PMBOK processes for better management and control of risks in projects. Dynamic modelling provides better control of risks and project managers will be able to forecast and manage project milestones more effectively.

10.		This research suggested the use of system modelling as communication tool for evaluating and gathering stakeholder expectations in a better and efficient manner. Since communication levels and skills are different for project managers and business stakeholders, and hence there is a gap among customer expectations. This results in scope changes, time and budget changes, and quality. System modelling was used at MIT-Portugal Green Islands project. The results show that the communication gap can be bridged and stakeholders' expectations would be satisfied more effectively.	The research showed that System modelling could bridge the communication gap between clients and project managers. PMs would be able to define models to define communications channels, means, processes, and manage the objectives, requirements, and expectations effectively and efficiently. The research shows that model would be able to provide framework to reduce communication gap and understand stakeholder expectation, which resulted in better scope, time and budget control.
11.		This paper proposed the use of object oriented model for project management. The hierarchical structure is used to represent the full development life cycle of the software project and provide a view of various parts to the project manager. The interactivity among various components of the projects is defined as relations among objects.	Project activities are represented in text and graphical form. Paper demonstrated the used of various object oriented properties like inheritance, relations, modular, and data encapsulation for sharing information through different phases of the life cycle of the project. Various objects could be reused in different projects for better control.

12.		This paper proposed an estimation model for determining the project effort based on use-case. Relationship between actual and estimated data is developed to be used for better estimates in future. The model works better in iterative environments as it allows comparing of successive developments.	The research suggested an estimation model based on actual and estimated data to predict better results in future. A mathematical model is created between actual and estimated data for more accurate forecasting. This model is more suitable for iterative development environment.
	Project Management in IT/ Software Projects	The research on software and IT projects had been discussed in the research papers [13-22]. Authors had explored not only the standard project management methodologies like PMBOK, PRINCE-2, RUP but also the new practices of Agile, JAD, RAD, extreme programming. Researchers had also suggested adaptations of project management models for managing complex projects in the software and IT industry.	
13.		This research paper discussed how the traditional process models in software engineering are being modified/ replaced with new web based models/ agile development due to more dynamic nature of projects and fast changing requirements. The changes in the client expectations and requirements are quick and frequent and hence requires new models which can be iterative, incremental like Agile, JAD, RAD, Extreme programming.	The research paper discusses how the traditional processes have given way to new web based, iterative, and incremental models which can cater to the new demands and requirements in the fast and quick changing world. The changes are expected in terms of look and feel, market demand, technological advances, and providing more efficient services. It discusses various models like Agile, JAD, RAD, extreme programming etc. These new models are capable of responding rapidly and meet stakeholders' expectations.

14.		This paper suggested that customisation and tailoring of regular project management methodologies is required to increase efficiency of processes in large scale complex software projects. The research provides guidelines and techniques for developing generic models for process improvement. The customised model would be more productive and having better analysing capabilities as project manager would be able to focus on the necessary requirements only.	This research emphasised that regular project management methods/ processes must be customised/ tailored in order to make it more efficient and avoid unnecessary details. The research found that customised models are better, more efficient and effective due to better alignment with current scenarios and objectives. This also provides project manager with better analytical skills to focus on the necessary details.
15.		This research suggested a simple and straightforward Project Matrix model for technical project management of software projects. The model requires no special training or resources.	The model is found to be efficient and highly effective in coordinating resources monitoring and controlling software projects. The paper demonstrated that model would be able to produce high quality software projects with ease.
16.		This paper proposed the integration of RUP and PMBOK for managing technical software development process of product lifecycle and management of project lifecycle respectively for efficient and effective management of projects and delivering high quality products.	The paper suggested that organisation would be able to automate various activities/ tasks in software development processes and project management with the integration of RUP and PMBOK methodologies. Using the capabilities of both RUP and PMBOK project manager would be able to manage projects more efficiently. This would in turn lead to better quality products.

17.		This research paper proposed the integration of standard software engineering practices with standard PM methodologies and framework to create a new framework for software development projects.	The results showed that new integrated framework would help to develop quality software project with better efficiency. Paper used standard software engineering framework from Spiral model, Waterfall model to create new framework integrated with PM methodology. This provided better planning, monitor and control, and execution of projects.
18.		This research paper proposed to make optimum utilisation of triple constraints of Time, Cost, and Scope as functions of project's high-level requirements/ business objectives. The new framework proposed extending the benefits of polarity management to triple constraints of PMBOK. Polarity management involves moving from focusing on one pole as the problem and the other as the solution (either/or thinking), to valuing both poles (both/and thinking). Good polarity management gets the best of both poles while avoiding the limits of either.	This paper suggested that integration of new framework which uses triple constraints as functions of business requirements/ objectives for optimum utilisation. It also suggested that polarity management could be used to manage the triple constraints of PMBOK more effectively and efficiently, since these constraints of time, cost, scope are opposite of each other.
19.		Government IT projects were analysed critically by this research. Authors tried to identify various challenges/ issues faced by e-government projects. The paper discussed the gaps in implementation of e-government projects, their monitoring and control as well as execution.	This research studied e-government projects and challenges faced by these projects. The study proposed that appraisal should be more systematic and periodic for successful completion. The appraisals have to

			be done in timely manner, risks and issues highlighted and thus controlling the projects efficiently.
20.		This research suggested the use of T-cube and Metromap visual tools for managing software development projects. These techniques use graphical and metaphor presentations to show various project management tasks. As the name suggests these techniques use Rubik Cube and Metro map metaphors.	The research proposed two techniques i.e. T-cube based on Rubik Cube and Metromap and tested them on real project data and found that these tools are effective and provide positive results for project management. The method provides graphical presentation which is easy to view/ track/ monitor the milestones and deliverables. This results in better project management with improved visibility.
21.		This paper suggested the application of software agent framework to help in managing various processes of software projects. Two comprehensive frameworks were developed to assist all the core and facilitating processes and functions of software project management.	The paper demonstrated that the use of software agent framework could significantly help in meeting market expectations and deliver projects as per the stakeholders' expectations adhering to schedule and budget. The framework assigns each agent to manage a small and manageable task, hence reducing complexity. The smaller tasks/ activities are easier to manage and thus providing better monitoring and control of project.
22.		This research discussed whether the existing project management methodologies like PRINCE-2 had been useful in the management of software projects and information systems.	The study suggested that the project managers may have to use some other tools for effort and budget estimation like function point, empirical etc. and performance measurement

		Organisations have to develop full scale quality management plan to ensure delivering a good quality software product efficiently and effectively.	techniques along with standard project management methodology. The research showed that organisations may have to use CMMI, or other quality management plans to manage the projects in a better controlled manner.
	Managing Projects in R&D organisations	Differences between managing projects in R&D organisations and other projects had been examined in papers [23-24]. Since R&D projects are knowledge intensive, hence gives rise to different set of requirements and expectations form stakeholders.	
23.		This research discussed an approach that emphasises on building relationship between project management and engineering processes for better management and improved performance of research projects and programmes. This had been used at systems management office at NASA Langley Research Centre.	This approach suggested implementation of good project management practices and processes with consultation of teams from the early stages and improving them with tailor made training modules as and when required using just-in-time approach. This methodology also takes care of improvements in processes and policies. The approach also emphasised on conducting reviews and assessments independently for value addition.
24.		This research paper discussed and analysed the differences among R&D enterprises and other organisations. R&D enterprises being knowledge intensive, therefore more emphasis has to be on knowledge management. Therefore a culture of sharing knowledge	This research confirmed that knowledge management system is needed to strengthen the R&D enterprise information system.

		by use of documentations, templates, and shared information systems has to be created.	The sharing of knowledge through shared workspace, intranet sites, documents, research papers, discussion and chat groups along with blogs would provide easier sharing of information and knowledge in the organisation.
	Empirical and Statistical Analysis	A number of empirical and statistical studies [25-33] had been conducted to investigate the success of various project management methodologies and frameworks. Data has been collected and analysed using various techniques in order to understand the effectiveness of diverse project management methodologies.	
25.		This study conducted a survey to find the experiences of people in project management. Survey finding were highlighted in terms of various methods, tools, techniques used and their effectiveness. Performance, project success factors and common criteria for managing successful projects were also studied.	The survey found that people are using different tools and techniques for similar kind of projects as per their skills, comfort level, and experience. The tools are also sometimes prescribed by the organisation, limited by legacy systems and availability. Some PMs have also tailored the standard methodologies to suit their needs. This provides them to model the system as per their needs and requirements and hence reduce the cost.
26.		This research studied various factors that influence the execution of project management and measure the performance of project management methodologies.	The study found that the 6 factors which have greater impact on execution of project management are Management commitment, financial constraints, organisational structure, reward system, education and training of project teams.
27.		This research explained the importance of scope management for successfully managing ICT projects. Standish group's CHAOS report states that only 1/3 of ICT projects are successful. Therefore project	This paper suggested that with proper scope management process in place and with good training of PMs on scope and

		managers need to manage scope and changes more efficiently and effectively. This paper describes various approaches and techniques used by the trained scope managers in USA, Europe and Australia which have increased the success rate of the ICT project.	change management, ICT projects can be completed more successfully. Paper highlighted the use of standard methodologies like PMI, PRINCE-2, and other PPM tools have helped the project managers to a great extent in managing the scope and deliverables. It also showed that different methodologies are popular in different countries.
28.		This research conducted an empirical study to identify the important factors in the success of software process management in software projects. The study was to find out the importance and prioritisation of other factors like baselining, user involvement, management commitment, change management and documentation etc. for successful completion of projects.	Study found out that synchronisation/ synergy of activities/ tasks/ processes is more important than other processes for the successful management of software projects. The study also found out that other factors for process management in order of ranking were baselining, user involvement, management commitment, change management, and documentation.
29.		This study tried to understand the effect of change on the methods, practices, and performance of ICT projects. The paper discussed the impact and challenges due to the dynamic nature of work and environment in the current scenario. The research focussed on finding the reasons for failure, and reviewed the tools, techniques, practices, standards. The also tried to analyse if these failure are due	The results showed that complexity of the projects had increased due to the dynamic nature of projects and quick and fast changing market demand and requirements. The research highlighted the use of new tools, methods, frameworks, and methodologies like Agile, RAD and software as a service, helps to deliver quicker solutions at less cost.

		to changing, dynamic or unstable nature of ICT projects and environment.	
30.		This paper discussed comparison had been done between modern and traditional project management. Author also discussed the key issues in the modern project management and challenges faced in current environment. It also explored the use or preference of one or other project management methodology by the project manager due to which there will be difficulty in managing projects which use different methodology or framework.	The paper suggested that in modern environment of ever changing requirements, new methods, tools and techniques are required to face the challenges and manage the projects effectively and efficiently. Study highlighted that client methodology could be different to the service provider and hence would create new challenges for project managers.
31.		This study explored the relation between project management assets and performance by considering project management assets as independent variables and project management performance as dependent variables. To analyse the advantage offered by project management assets, analysis of online survey by 198 PMI members was done.	Seven factors were characterised for project management assets, three factors for organisational support and two factors for project management performance. The findings of the survey showed that project management assets give a competitive advantage to the organisations.
32.		This research studied the application of PMBOK 2008 standard processes to manage Enterprise Project Management (EPM) system in one of the organisations. The authors reviewed how the EPM project was implemented and its status based on the data collected by them. They proposed number of concepts to reduce the time and budget and enhance the system for better efficiency.	The study proposed that critical path management and PERT techniques could be used along with customisation of processes for the needs of the organisation. These methods help to track, monitor and control the projects in a better manner with increased visibility of the critical tasks, activities and parameters.

	Use of Alternative Methodologies	Some researchers [33-38] had used alternative methodologies and statistical techniques in the project management area. The investigations had used approach-avoidance theory, Fuzzy logic, NPV etc. for project management.	
33.		The paper described the use of approach-avoidance theory to develop integrated process model for managing escalation and de-escalation process in IT projects. Authors had used a process model to identify conditions, critical incidents, sequence of actions, and consequences over the life cycle of the project. The study had been done at various levels of project, organisation and environments to get an insight into the approach-avoidance decision of escalation or de-escalation and the stakeholders' response to the same.	The study suggested that approach avoidance theory may be useful in some cases, depending upon the critical path activities, incidents and when to escalate or de-escalate the decisions/ situations to the stakeholders. Various actions can be categorised into critical to low priority. This would give a view to the project managers for escalation or de-escalation of the decisions to the stakeholders.
34.		This research proposed a conceptual model to represent the actual project performance. Author had done the feasibility study by way of questionnaire and interview data. Paper highlights the management skills and factors required for managing the project performance and difficulties.	The factors of technical knowledge, estimating skills, critical path methods, and management skills are required in both the technical as well as management areas of cost, schedule etc.
35.		This study focused on the use of Fuzzy logic for critical path analysis and other PM activities. The approach also determines the significance of activity and path along with critical path. This is very useful in risk management and the method is able to manage the uncertainties.	The study suggested that the fuzzy logic would be quite useful in determining the activity, its significance along the critical path, and managing the risk more efficiently. The project manager would have better view of the critical path and risks and the actions they need to take for managing the projects efficiently.
36.		This research paper described that the project success and performance would be measured in terms of output benefits realised.	Paper presented a concept of managing project scope through utilisation map of the outputs.

		Authors explained a technique to establish a cause and effect relation between output utilisation and target outcomes.	The fishbone or cause and effect diagrams, decision tree analysis are effective tools for mapping & managing the projects effectively.
37.		This study discussed the utilisation of Net Present Value (NPV) as a tool to better project management. Author highlighted the fact for successful monitoring and controlling of the project, NPV should be used. This can be the most important tool for finding the suitable solution.	The author demonstrated that NPV could be one of the most efficient tools for decision analysis and resolution for successful monitoring and control of the project. NPV can provide better budget control and managing the cost and in the process managing the schedule and scope efficiently.
38.		This study described the relationship of project management with other allied disciplines in the field of management. The research is based on the study of 18 top management and business journals, publications and then divides them into 8 categories. The categories are (1) Strategy/Portfolio Management; (2) Operations Research/ Decision Sciences; (3) Organizational Behaviour/ Human Resources Management; (4) Information Technology/Information Systems; (5) Technology Applications/Innovation; (6) Performance Management/Earned Value Management; (7) Engineering and Construction; and (8) Quality Management/Six Sigma.	The study suggested that close relationship among various categories and disciplines. It requires good coordination among various processes and disciplines for successful completion of projects. PMs have to use somewhat different skills, techniques, tools to execute, monitor and control different category of projects. Therefore for web projects management technique is different form COTS projects, which is different from infrastructure projects and so on.
	Effects of Leadership and Management	Effects of leadership and management qualities of project manager along with communication channels for managing projects had been explored by some researchers [39-42]. The importance of IQ, EQ, and MQ had also been studied. Teaching of proper project management tools and software is also stressed.	

39.	Qualities of Project manager	This research study discussed the impact of personality and behaviour of project manager on the project types and the success of the projects. A questionnaire was developed to evaluate the relationship of project manager’s behaviour and personality with project type and success rate. The four types of projects considered were Urgent, Complex, Novel, and Normal and they are judged with three constraints cost, time and quality of projects.	The study showed that managers with team leading and management skills and who had better communication skills were more successful than others. These managers were found to be building an environment of trust and loyalty with good understanding of human needs. The motivational techniques are different for different level of people in the organisation and project managers must be able to address these issues and the strategy would have to change appropriately for different complexity of the projects.
40.		This research paper discussed various issues related to IT projects such as uncertain, unique, fast changing, short term, etc. The study emphasised that the project manager play a key role in successful delivery and implementation of IT projects.	Project managers must explore various communication channels with all stakeholders so that they can get and circulate proper support and information from all sides. This would ensure building long term relations and synergy with clients, project teams and various stakeholders.
41.		This paper studied the effects of leadership quality on the success of different type of projects. Authors studied the impacts of IQ, EQ, and MQ of project manager/ leader on the success of the projects with different level of complexities. Study used factor analysis and moderated hierarchical regression analysis to analyse various responses and data gathered.	Analysis showed that there is a relation between EQ, MQ and project success but are moderated differently by the complexity of the projects. EQ and Project success relationship is moderated by the complexity of faith, whereas MQ and project success relation is moderated by both complexity fact and faith.

		Authors also did variance and non-parametric tests to see the means and medians of EQ, IQ, MQ, complexity of faith, fact, and interaction.	Project success is directly affected by the interaction and its complexity.
42.		This research paper discussed the issues of teaching project management as part of system analysis. Most of the training/ teaching programmes just put emphasis only on drawing Gantt chart or PERT chart for planning without using proper PM tools and skills. Therefore, the project plan could not give a full picture of the project and issues.	Authors suggest that proper tools, skills and techniques must be given to the aspirants along with proper assignments and tasks. PMs should use good project and/or portfolio management software for completing the assignments and tasks.
	Project Management in Global Distributed Environment	Managing projects in global distributed has its own challenges [43-66]. Researchers had explored use of different methodologies, techniques, tools for managing distributed projects from standard processes to incentive based approaches.	
43.		With the exponential growth of communication technologies and information systems, the globalisation of the commercial world has also increased significantly.	This research paper highlighted that in order to increase efficiency, productivity, quality and cost effectiveness, organisations are going for outsourcing and distributing their wok globally.
44.		This research study described the importance of software requirement specification (SRS) document to the success of global software projects. The authors discussed various difficulties in creating a standard SRS as companies have their own methods of creating such documents.	The authors studied how Capgemini overcame the issue of creating standard SRS by using specification patterns so as to create synergy among the global teams.
45.		The significance of knowledge sharing among global teams and stakeholders and how it can be addressed by mature processes and tools is highlighted in this study. There will be lesser	The authors proposed that enterprise wide software should be used for project assurance, quality and knowledge sharing.

		readjustment required if the processes, methods and tools are used enterprise wide.	The software would help provide timely information, data and visibility for the preventive and corrective actions to be taken for better execution of the project.
46.		This study described the team structure for successful completion of offshore projects. The authors studied two types of structures for offshore teams and highlighted the problems faced by managers for changing the team structure and organisation model.	The paper proposed that changes have to be done to the existing structure for successful global operations. The team structures for managing offshore teams for various phases of the project and the reporting structure has to be managed keeping tin to account various time zone issues, cultural issues and skills availability.
47.		A framework for managing risks in global software projects is proposed in this research paper. The integrated framework had been created for distributed projects based on various parameters and requirements of global environment.	The framework proposed the use of various communication channels, different set of development environment for different needs/ requirements of the stakeholders and projects. The flow chart could also help to provide better information across the organisation.
48.		This research studied the impact of communication media like email, messaging, phone etc. on the conflict resolution in global teams. The authors tried to evaluate which could be the best sequence or combination of media tools for communication for resolving the conflicts.	The study showed how the cross cultural issues, different communication channels, time zone management had to be taken into account for managing global teams/ people effectively. The process for conflict management has to be robust and transparent so that the conflicts can be controlled/ resolved in an efficient manner.

49.		In this study, authors tried to analyse the global development projects using framework so as to overcome various issues in the distributed projects. The authors tried to study the processes used by various organisations to manage the distributed projects efficiently and effectively, and maximise the benefits of onshore-offshore delivery.	The paper showed different models and frameworks used by global organisations to manage the distributed projects successfully. Various activities can be distributed offshore/ near-shore or onshore and also the life cycle divided among them for maximising the benefits.
50.		This research studied different communicating media and its application the global agile software development projects.	The authors found that instant messaging is a good substitute tool for face to face communication and email is good tool for wider and enterprise wide information sharing.
51.		This research paper proposed predicting the outcome of global software development projects with the application of analytical modelling. The analytical models are parameterised to accommodate the single-site or multi-sites, team sizes, skills levels, expertise, availability, and support level etc.	The paper suggested various types of models for distributing various phases/ stages between offshore and onshore sites.
52.		This research study described the processes for managing a multi-site software development project is complex and requires a very good collaboration among teams.	The study suggested management of multi-site projects can be improved using networked virtual environment which allows for better communication, familiarity, sharing, mentoring, faith and faster resolution of conflicts.
53.		This research studied the growth of teams in distributed software development projects. The authors had tried to study the growth of teams in terms of expertise, communication skills, economic impact and working conditions.	The study described the communication channels, skills and the impact of virtual communication techniques for successful management of teams and projects in global environment.

			The better the economic and working condition, the better would be the team morale and more successful project management.
54.		This research paper explained that the "Distributed Work" is basically a number of different work provisions. Since the teams are distributed globally, and are separated by time zones, the managers have to rely heavily on the availability and efficiency of communications tools and information systems.	The research highlighted the importance of communication tools and information systems for successful management of global teams and projects.
55.		Use of incentive based theories to the distributed work environments is described in this research paper. The paper endeavours to address two subjects; firstly, to understand the effect of incentives on the worker's choice for using distributed work environment, and secondly the collaboration of multiple incentives or disincentives across organisation, groups or individuals. This paper also looks into motives as to why people always prefer to take up distributed work environment. The theory of incentive is applied to two organisations to understand the behaviour and pattern.	The research suggested that people prefer distributed work environment because of flexibility, incentives, and availability. The disincentives are managing different time zones and culture. The study showed that incentives highly influence the working of people and opting for distributed working. It also highlighted that work life balance is one of the main criterion for people for remote/ home working.
56.		This research paper studied as why organisations choose for distributed work environment. The research was conducted to understand the use of distributed work environments in terms of costs, efficiency and productivity, motivation of employees, and impact on the group's outputs.	The research suggested that the use of distributed work environments is to mainly reduce the costs, improve efficiency and productivity, motivate employees, and impacting the group outputs positively.

57-60		Even though there is clear impact on the employees for the work-life balance, more flexibility but there are conflicting observations made which are owing to more distractions at home which results in increased stress.	These papers showed that remote working, home working or flexible working is able to provide better work life balance but at the same time needs more planning as it could also lead to more distractions at home and less work. The employees have to manage themselves more efficiently to be more productive. Organisations provide hot-desk facilities to save on cost of space and also improve its travel carbon footprint.
61.		This research paper defined knowledge intensive firms as those that "offer to the market the use of fairly sophisticated knowledge or knowledge-based products". Knowledge intensive firms can be divided into professional service, and research & development firms such as engineering and law firms or pharmaceutical companies. Knowledge intensive firms differ from other types of organisations through the organisation's massive reliance on the intellectual skills of its employees to carry out its core functions.	Although many of the problems and barriers to distributed work are not unique to knowledge intensive firms, the sophisticated nature of the knowledge these firms typically deal in has the potential to magnify these problems. This report focuses on the interaction of individuals and teams within knowledge intensive firms and the ways that they interact and perform under distributed work arrangements.
62.		This research defined a virtual team as "groups of people employed in a shared task while geographically separated and reliant on electronic forms of communication".	The research paper compared various factors such as telephonic conferences, video conferences, e-mails, time zones, and for managing virtual teams. The virtual communication tools are important and also people should be sensitive to the cultural communication styles and language used in communication to overcome misunderstandings and reduce communication gap.

63.		The paper defines the term remote resourcing as “carrying out work in an office remote from the point where a project is principally delivered”. The report defines remote resourcing when virtual communication tools are used and teams are distributed at one or more sites in different geographical locations.	These terms essentially describe interactions between people separated by physical distance who perform most of their work through communication technology. Within the body of this report the term distributed work is used to represent this concept. The dynamic changes to the project are handled more effectively when the team is at one place and long-term projects can get greater benefits from remote teams or by distributed working.
64.		The research paper discusses that distributed work covers many alternative methods of work which include satellite offices, flexible work arrangements, telecommuting and global collaborative teams.	The paper describes that distributed work could be defined in many different ways. The distributed teams could use different ways of working from flexible home working to offshore, onshore or near-shore arrangements. The paper highlighted that distributed teams and working are often used to reduce overall cost and improve services.
65.		This paper describes various issues and problems faced by distributed work faces which are similar to all the issues and problems that normal collocated group’s face, with the added complexity of workers being based at locations remote from each other, be it in the next room or in another country The inclusion of IT as a required element of many definitions reflects the importance of ICT as a replacement media to mimic the communicative and collaborative qualities inherent in collocated work groups.	This paper highlighted that distributed work faces many more problems in addition to the normal projects at one site. The projects and teams distributed in different locations brings in the importance of good communication media and skills, cross cultural issues and management, time zone management, and clear understanding of the stakeholders’ expectations.

			The project documentation has to be detailed and shared with all teams highlighting various milestones and deliverables and also giving details of communication requirements.
66.		This research explained that small and medium enterprises (SMEs) are also facing huge competition due to globalisation of economies and easier availability of cheaper and good quality products, services across the world.	This paper highlighted that in order to stay ahead of the competition and technology SMEs should focus on to e-collaborations through project management approach. This will ensure them structured processes, better visibility for managing the full life cycle of the project and giving them better monitoring and control of project execution.
	Project Management Maturity Models	Various maturity models have been developed in the area of project management [67-76]. Maturity models help in assessing the capability and maturity of various processes, tools, techniques and management methodologies in an organisation.	
67.		This research studied the maturity levels of project management in different industries. They surveyed 126 organisations based on 42 components of maturity. The investigation also studied various industries and formed it into four groups i.e. professional, scientific, technical services; information; financial and insurance; and manufacturing.	The research found that maturity level is 2 out of 5 w.r.t. 36 components out of 42 analysed. The results showed that the maturity level of the four groups i.e. professional, scientific, technical services; information; financial and insurance; and manufacturing are similar across industries barring a few exceptions.
68.		The use of maturity models in improving project management practice is discussed in this research paper. The paper analyses the current maturity models for project management.	The analysis showed that the maturity models are mostly used reactively rather than proactively. The study also emphasised the fact that more empirical evidence and research is required to establish relationship of project performance with project management maturity models.

			The organisations that are using maturity models like CMMI are found to be in greater control of the projects since there processes are mature, well documented and provide good planning.
69.		This research paper presented a Project Management Process Maturity $(PM)^2$ model to evaluate and compare project management levels of organisations.	PM^2 model provides a well-structured model for evaluating project management maturity level of organisations. The model takes into account PM processes, factors and characteristics and shows the organisation's progress from functional to project driven organisation. The model helps organisations to enhance their project management approaches, create better documentation and plans.
70.		This research paper proposed a maturity model which has thee maturity levels with continuous improvement group of Key Process Areas (KPAs). The paper has taken ISO 9001:2000 as base for quality management. Each KPA is mapped onto plan-do-check-act (PDCA) cycle. Conical structure is developed for displaying the gradual development of KPAs in a better manner. KPAs are developed till they attain a dependable maturity level for project management. These KPAs may have to be improved continuously in order to respond to the changes.	By defining KPAs and then improving those continuously using PDCA cycle would enable the organisations to manage the projects more effectively and efficiently. By clear mapping of the KPAs to PDCA cycle, organisation would be able to improve the management and delivery of projects continuously. Thus organisations can work to optimise the processes for effective and efficient delivery of the projects.

72.		PMI, USA provided a very useful maturity model for organisations OPM3 to reflect their maturity with the best practices achieved within the project, portfolio, and programme domains.	OPM3 tries to link organisational strategy to successful, consistent, and predictable project completion. OPM3 divides the process improvement into four sequential stages i.e. Standardise, Measure, Control and continuously Improve.
73.		IEEE developed a standard for Software Project Management Plans (SPMP), IEEE std. 1058-1998. This applies to all types of software projects and all sizes.	This IEEE standard specifies format and contents of SPMP but does not specify technique to be used or examples. This standard provides information and document for managing a software project The standard defines the technical and managerial processes necessary to deliver the project requirements.
74-76		Capability Maturity Model Integration (CMMI) provides a framework for process improvements across the enterprises. The models have been used in many organisations since 1995 when the models were first created.	This framework gives applications of principles, practices, and objectives to achieve enterprise-wide process improvement. Many organisations have been able to manage budget and times efficiently with enhanced productivity and quality of projects using CMMI. Use of CMMI helps organisation to grow from Level1: Initial, Level2: Managed, Level3: Defined, Level 4: Quantitatively Managed to Level 5: Optimising. CMMI provides two representations: continuous and staged. The continuous representation allows the organisation to focus

			on the specific processes that are considered important for the organisation's immediate business objectives, or those to which the organization assigns a high degree of risks. The staged representation provides a standard sequence of improvements, and gives a basis for comparing the maturity of different projects and organisations. The staged representation also provides for an easy migration from the SW-CMM to CMMI

13.2 Software Process Engineering Metamodel (SPEM)

SPEM Language is designed to model software and systems development processes and their components. As per SPEM 2.0 [84] Scope of SPEM is purposely limited to define any software and systems development process, without adding specific features for particular development domains or disciplines (e.g., project management). The focus of SPEM is development projects and it does not provide a generic process modelling language or a behaviour modelling approach.

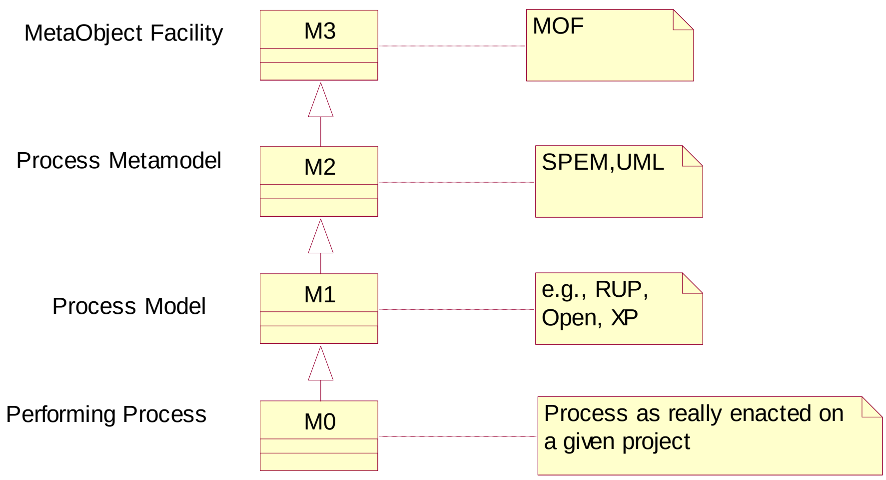

Figure 13.1 Meta Model presentation of SPEM

Developer/ Implementer can select the generic behaviour model that best fit their needs and also select specific structure to enhance the generic behaviour model. SPEM can be modelled using UML or BPMN notations [85] to describe the actual development process. These two languages are supported by OMG (Object Management Group) an organization which aims to approve and maintain open standards for object-oriented applications.

The SPEM 2.0 meta-model [84] is structured into seven main meta-model packages as depicted in Figure 3.2:

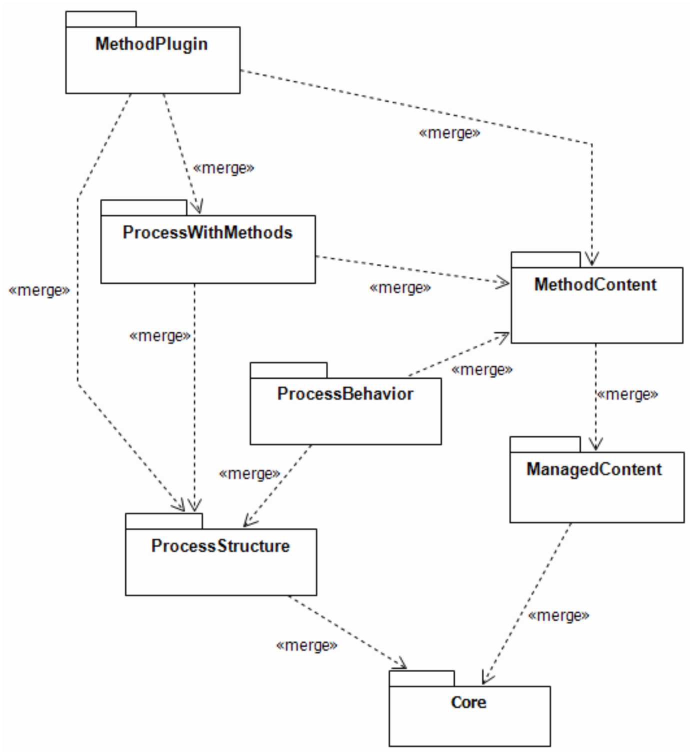

Figure 13.2 Structure of the SPEM 2.0 Meta-Model by OMG [1]

The structure divides the model into logical units. Each unit extends the units it depends upon, providing additional structures and capabilities to the elements defined below. Overall, the UML 2 package merge mechanism applied to the packages realizes a gradual extension of the capabilities modelled unit by unit. As a result, units defined on a lower layer can be realized by a SPEM 2.0 subset-implementation without the higher level units. In many cases, meta-model classes are introduced in a lower level package as simply as possible, and are then extended in higher level units via the package merge mechanism with additional properties and relationships to realize more complex process modelling requirements.

13.3 Business Process Model and Notation (BPMN)

According to Forrester, BPM is a discipline for improving and redesigning business processes from an outside-in perspective—spanning people, systems and organisations. BPMS are integrated tools that support process improvements by designing, executing, monitoring and optimising cross functional processes.

BPM is not a technology. BPM is a comprehensive set of

- ✓ Methods
- ✓ Tools
- ✓ Practices
- ✓ Technologies

Used by businesses to

- ✓ Design

- ✓ Enact
- ✓ Analyse
- ✓ Control

operational systems and processes.

BPMN [85] is a notation of the business process management methodology. This model and notation is comprised of a set of standard notations and icons suitable for designing a process. The overall aim of BPMN is to provide support for both business and technical users for defining/ developing the models/ notations for management processes.

Business process modelling with UML:

- Is a single modeling language enough?
  - UML describes system behavior
  - Existing UML extensions for business modeling are described in terms of OO concepts, with which most business users are unfamiliar
  - A single modeling language to span all the abstractions required by business users, analysts, systems designers and developers is open to interpretation
- Using UML to describe Scope or Enterprise perspectives:
  - Takes it out of its original domain; and
  - Requires us to map the existing symbol set onto different concepts

BPMN and UML will co-exist:

- OMG and potential for BPMN-UML convergence
- Technical users may continue to use UML
- BPMN can be used to drive solutions that will run directly on a BPMS
- BPMN can be used as a business analysis front end for subsequent systems development using UML
  - UML users would then regard business processes merely as another type of component

13.4 Petri Nets

These were introduced by Carl Adam Petri [90-94]. The main features are:

- A diagrammatic tool to model concurrency and synchronization in distributed systems.
- Very similar to State Transition Diagrams.
- Used as a visual communication aid to model the system behaviour.
- Based on strong mathematical foundation.

Definition:

- places, transitions, inputs, outputs
- firing enabled transitions

Modelling:

- concurrency and synchronization

Properties of nets:

- liveness, boundedness

Implementing Petri net models:

- centralized and decentralized schemes

A Petri Net Specification

- consists of three types of components: places (circles), transitions (rectangles) and arcs (arrows):
  - Places represent possible states of the system;
  - Transitions are events or actions which cause the change of state; And
  - Every arc simply connects a place with a transition or a transition with a place.

A Change of State:

- is denoted by a movement of token(s) (black dots) from place(s) to place(s); and is caused by the firing of a transition.
- The firing represents an occurrence of the event or an action taken.
- The firing is subject to the input conditions, denoted by token availability.
- A transition is *firable* or *enabled* when there are sufficient tokens in its input places.
- After firing, tokens will be transferred from the input places (old state) to the output places, denoting the new state.

BoundedNess:

- A Petri net is said to be k-bounded or simply bounded if the number of tokens in each place does not exceed a finite number k for any marking reachable from M0.
- A 1-bounded Petri net is also safe.

Liveness:

- A transition is dead if it can never be fired in any firing sequence.

Other Types of Petri Nets:

- High-level Petri nets
  - Tokens have “colours”, holding complex information.
- Timed Petri nets
  - Time delays associated with transitions and/or places.
  - Fixed delays or interval delays.
  - Stochastic Petri nets: exponentially distributed random variables as delays.
- Object-Oriented Petri nets
  - Tokens are instances of classes, moving from one place to another, calling methods and changing attributes.
  - Net structure models the inner behaviour of objects.
  - The purpose is to use object-oriented constructs to structure and build the system.

Table 13.1 Mapping of SPEM, BPMN, CMMI, Petri Nets

Standard Process Structure	SPEM Notations	BPMN Notations	CMMI-DEV Components	Petri Nets
Process	Process ProcessComponent			
LifecycleModel	Process Iteration			State Transition diagrams
Combination	Phase	Embedded Sub-Process	Maturity Levels	
Activity	Discipline Activity	Embedded Sub-Process	Process Area (PA)	Change of State Tokens Transitions
	TaskUse	Task	Specific Practices (SP)	
			Specific Goal (SG)	
	Step		Subpractices	
Artifact	WorkProductDefinition WorkProductUse	Data Object	Typical Work Product	
Resource	RoleUse RoleDefinition	Pool Lane	Stakeholders	
Procedure	Guidance Guideline ToolMentor Template Checklist	Text Annotation	Subpractices Generic Practice (GP) Elaboration Shared Vision Amplification	
PatternofActivity	Step	Specific Practices (SP)	PatternofActivity	
Restrictions	WorkSequence ContentDescription Goal Precondition WorkDefinitionParameter Category WorkProductRelationship	Rule	Generic Goal (GG) Generic Practice (GP) Purpose Statement Introductory Notes Related Process Areas	Boundedness Liveness

There are a few problems concerned modelling project management processes. This is because Initiating, Planning, Monitoring and Controlling, Executing and Closing project management activities involves interactions with development processes.

PMBOK describe several techniques that enable such interactions. To name a few PMBOK processes which have interactions can be described in the areas of Scope management, Performance Reporting, Project Communication Management, Change Management, Stakeholder management, Quality Control and Quality Assurance processes.

Performance reporting process defines project status, status meetings, and several systems, that enable project related information (scope, schedule, cost, time, risk & issues, and quality) to project manager and all the relevant stakeholders.

There are several problems connected with modelling various PMBOK processes and knowledge areas. A few of them are highlighted below:

First problem is how to present Scope Management activities. Scope Verification activities belong to kind of activities that takes place, when certain deliverable is ready. This issue usually comes from stakeholder traced into functional and technical requirements which comes later at software development life cycle model as goal of phase. Scope Verification activities can also emerge inside a phase, as intermediate deliverables are ready.

Second problem is how to present reviews, which occurrence don't depend on finishing deliverables, only are cyclic, or are evoked by other events, such as status meetings, peer review meetings, testing, or quality audits.

Third problem is how to present outputs from project management processes, which have influence on development processes.

Above are some the issues which will come if SPEM processes were to be used for developing the models.

Since this research is focussed on modelling PMBOK, the complexity and problems using SPEM would have been higher with more notations and processes. The SPEM processes may be in conflict with the PMBOK processes, as SPEM has limitations in PM areas as the standard suggested.

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